

OMNI

**COMPLETE CATALOG OF COMPUTER
HARDWARE AND ACCESSORIES**

EDITED BY OWEN DAVIES



**The Indispensable Guide to Microcomputers
for the Home and Business**

**The Best in Add-ons: Monitors, Printers, Modems, and
Every Accessory to Build Your Own Super System**

—What's Coming in the Next Generation—

—Micros Organized by Price Ranges—

—Money-saving Advice from the Best-known Experts—

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OF COMPUTER HARDWARE
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EDITED BY OWEN DAVIES

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THE SIX-MONTH SYNDROME

By OWEN DAVIES

To buy or not to buy, that is the question that nags would-be computer owners. If you buy now, you can start to use your computer before the day is out. But if you wait six months or so, the same machine will probably be cheaper, and far more powerful ones will be available.

It's a real dilemma, and this year it's at its peak. According to some estimates, new computers are appearing on the market at a rate of one a day.

Yet, most computer users claim there's really no decision to be made—other than which machine to choose. "At any given moment there's a valid reason to buy now; it's just a different reason for different people," says Carl Helmers, a widely respected industry analyst who earned his prominence as founding editor of *Byte* magazine, the microcomputer world's first mass-market monthly for nonengineers.

"It depends on what you want to do," adds science fiction writer Jerry Pournelle, a veteran computer user, *Byte* columnist, and contributor to this book. "If all you want is to play games, it probably doesn't much matter when you buy it. But if you run any kind of business, you should have bought one three years ago. The point of having a computer is not the hardware; it's what the machine will do for you. If you write, if you do any significant financial analysis or record keeping, then the efficiency you gain in the next six months could repay the cost of the computer."

That is, if you pick the right one. It may not be easy. "It's possible to buy a good machine without worrying about technical data," says Mark Garetz, president of CompuPro, a Hayward, California, computer maker with a reputation for building high-quality equipment for the knowledgeable "hacker." He cautions, though, that "it's also possible to buy really bad machines with specs that sound really good. The 'specsmanship' in this business is really incredible."

Much of the jargon you'll face centers on the microprocessor, the chip that does the actual computing in your computer. A computer's power depends on many factors. Three are built into the processor: the number of bits it crunches at a time, its "clock speed," and its "instruction set."

A "bit" is the smallest unit of information, equal to the flip of a single switch in the computer's processor or memory. For practical use, bits are assembled into units of 8, known as bytes, or 16, known as words. One byte is roughly equivalent to one letter of text. In the computer's binary arithmetic, far larger numbers can be expressed in a word than in a byte; so heavy number-crunching can in

theory go faster on a 16-bit computer than on an 8-bit machine. It doesn't always work out that way.

A computer's clock speed governs the number of times each second that the microprocessor can flip the switches in which it stores information—the smallest unit of work it can perform. A microprocessor running at a clock speed of 8 megaHertz, or 8 million cycles per second, can do four times as much work in an hour as an identical processor running the same program at a clock speed of only 2 MegaHertz. Most popular microcomputers fall somewhere in this speed range.

By far the most complicated factor is the microprocessor's instruction set—the vocabulary of primitive orders that controls the microprocessor. Ignore it. Promotional fliers occasionally babble about the powerful instruction set of the chip used in the machine being sold, and in general it's true that a large, well thought-out instruction set makes for a more powerful processor, while a limited one makes it difficult to write versatile, easy-to-use programs. But the programmer's skill is usually a far greater factor in how well a computer works for you.

"How important these technical details are depend on what you plan to do with the computer," Garetz observes. "For simple word processing, a well-designed 8-bit machine is more than adequate. The big advantage of 16-bit computers is not that they are more powerful but that they usually have a larger memory. This can be important when you have a lot of data to work with—running an accounting program, for example. If you are doing that kind of computing, you will also need high-capacity disk drives to store your information permanently."

"The way the machine and software are designed is just as important, though. A poorly designed 16-bit machine is not likely to perform as well as a well-designed 8-bit computer. And software that's inefficient or hard to use can undermine the best equipment."

Garetz suggests setting up a personal "benchmark" against which to measure the computers you consider. "Figure out a typical use for your computer, and try running that program on different machines. Then take a closer look at the ones that seem best at what you intend to do. This won't necessarily find the best machine, but at least it should help you rule out any that are really wrong for you." For further hints on how to find the computer that's best for you, see Jerry Pournelle's informative essay, "Getting in on the Computer Revolution," later in this book.

While you're searching for the right machine, of course, you'll run across all those new computers just about to enter the market, and the six-month syndrome will set in again. This year's generation could make the dilemma even more acute.

"Look for a bunch of new portables," Carl Helmers advises. "They'll have plenty of memory, a flat-screen display, and two-micro-floppy disk drives that store fairly large quantities of information. They won't weigh more than ten or twelve pounds, and they'll cost only \$3,000 or \$4,000—about half the price of the closest equivalent now available."

If you can stand to wait longer, he adds, the advantages of delay will seem even more attractive. Five years from now, he predicts in an essay in this volume, computers will shrink to the five-pound range, yet carry the memory of today's largest micros—half a million bytes or so—and the number-crunching power of a much larger machine.

But be honest. You may not need all those wonderful new features. One writer at *Omni* dithered for two full years, waiting to see what would come next. Then he bought a computer that had been on the market when he began his deliberations. The manufacturer's reputation for quality and speedy repairs, he finally decided, meant more to him than state-of-the-art technology.

"My company, North American Technology, bought several Apple computers four years ago," Helmers adds. "We're still using them, and I expect them to be in use five or ten years from now. We have other, more up-to-date computers as well for things that the Apple can't handle. But what difference does that make if the older machines still do the jobs for which we bought them?"

"People are going to have to get used to it," he concludes. "There will be a new crop of computers every year. As soon as you understand that, it no longer matters that yours isn't the latest. Just be sure to get one that suits your needs."

That is the purpose of this book: to help you find the system that best accomplishes your goals. There is no way to fit the entire small-computer market into a single book—not even an encyclopedia—but our reviewers have done their best. There are inexpensive computers here and costly ones; small, games-oriented machines and state-of-the-art business computers—even a few multi-user models. And peripherals and accessories of all kinds. Each has been reviewed by an experienced computer user with first-hand knowledge of the equipment. It's the largest selection of computer hardware ever evaluated in a single volume. Somewhere in it is the system for you.

GETTING IN ON THE COMPUTER REVOLUTION

by JERRY POURNELLE

I love little computers. When I was a boy and read science-fiction stories about the coming computer age, I always thought I'd someday work with a good computer. I never dreamed I'd *own* a machine as good as those in the Heinlein stories.

A lot of my friends tell a similar story: People they respect are excited about small computers. Everyone is talking about the little beasts. If you're not computer literate, you're headed for economic extinction. If you don't teach your children computer literacy, why, you're a monster who deprives them of the necessities of life.

Small computers are the wave of the future. Everyone says so.

The problems begin when you go out to buy one. My friends don't want to spend a lot of money, but they're not really trying to be cheap about it, not while the kids' future is at stake. Why not shell out a few hundred dollars? Right then they make a discovery—most machines cost a lot more than the advertised price. It's as if dealers quoted the price of automobiles, and when you went to drive away with one, the salesperson pointed out that "the base price" didn't include motor or brakes.

So, about a thousand dollars later, they take home the machine. Then comes the second horrible discovery: You can't do very much with it. It will balance your checkbook, but who's willing to enter all that data? It's easier to use a calculator.

As for keeping recipes, a box of file cards is faster and works better with less fuss. Some of the small machines are pretty great at video games, but surely there must be more to the excitement than *that*?

There is. But, alas, really getting in on the micro revolution is more expensive than all the hype from computer salespeople and magazine ads leads you to believe. I think it's worth the expense, but the buyer ought to know what he or she is getting into.

Real computers, as opposed to toys and games machines, aren't cheap.

First principle: Let's establish some first principles for those in search of a way to get in on the computer revolution.

You won't know what you want to do with your first computer. Forget all that garbage about figuring out exactly what you want the machine to do, about choosing software first then buying a machine to match. If you do that, you will get too limited a machine, and you'll soon be unhappy with it.

Besides, if you're like most of us, you don't really

know why you want a computer. You're just certain there must be something behind all that excitement.

A useful first principle: Get the most powerful machine you can afford. No matter what you wanted the machine to do, it will do both more and less than you expected; after it has done more than you bought it to do, you will want more yet. Anticipate your expanding wishes, and get a machine with real potential.

Second principle: If you don't know what you're doing, deal with people who do. Unfortunately, that means that many of the bargains you see advertised in the magazines will not be available. Most of the computer horror stories come from people who bought heavily discounted equipment by mail, then discovered they couldn't get it to work. The outfits that offer really heavy discounts cannot possibly afford to hold beginners' hands.

Third principle: Stay with the mainstream. Don't let yourself be sold a system that can't communicate with the rest of the microcomputer world.

Understand that there's no single answer to your problem. For instance, the most software is written for machines that are IBM PC compatible, but the rub is that the IBM PC-compatible machines are not the best machines on the market. They are not the most powerful, not the fastest, and not the best made. IBM machines are good, well made, well designed, but technologically well behind the times. The PCjr is even more so—it is a PC that was deliberately crippled so that it wouldn't compete with the PC. (There will be upgrade kits for the jr, power supplies and more, but if you're into doing that sort of thing, you needn't read this. If you know how to upgrade equipment, get the catalogs, put together a good S-100 bus system, and blessings.)

The problem is that to be 100 percent PC compatible—and none really is—the machines have to do things the way the IBM does, which means that designers have to downgrade the equipment. The more compatible with IBM, the less technologically advanced the design.

While you'll want the capability to use much of the software written for IBM machines, you needn't insist on 100 percent PC compatibility. Things are rapidly happening in the micro world. Good stuff comes out all the time. If you want to keep up at a reasonable price, and get in at a reasonable time, then there are other and better paths than just forking out money to Big Blue.

Given some of these principles, we can look at some specifics.

There are a very great number of small computers. No one can possibly be familiar with all of them. In my discussions below, I'll speak mostly of machines I have owned or otherwise have personal experience with. This means that I will of necessity neglect some others.

I have over 20 small computers in my house. Thus, although I don't know *all* small computers—and I doubt that anyone else does either—I do know about a lot of them.

HOME COMPUTERS

There are a number of fine machines you can get at a very low cost, but after you have bought them, you will discover that the prices are not as low as they look. The Kaypro advertisements in which the customer asks, "How much is the \$895 computer?" and is told that it costs \$2,195.50 has a great deal of truth to it. If you buy a cheap home computer, by the time you have added enough equipment to make it useful, you will find that you have spent more than you thought.

The typical home computer is great for games and for teaching elementary "computer literacy"; for example, learning what "reset" means and the rudiments of BASIC, as well as for having fun. The Atari 400 and 800 (now unavailable; the new Atari home machines are all right, but not as big a bargain as the old 800) were excellent beginners' computers.

However, none of the "home computers" is very useful for professional work, business, or writing. True, some writers do use them, and there is some business software for them. It's also true that some writers continue to work with ballpoint pens, and I am told that a few accountants prefer mechanical adding machines.

The Apple IIe is in a class by itself. It is the minimum useful machine, and can indeed be upgraded into a serious writing and business computer. However, when you have bought everything you need, it will have cost a lot more than you expected. You will have an excellent games machine and a pretty good business computer, but it will still be limited, and it can never be made IBM PC compatible (well, it can be done, but it's expensive and inelegant).

The Apple IIe does have advantages for teachers. There will be a lot of them out there in schools. Moreover, kids at home who have an Apple IIe will be able to play with the machine their school is likely to have. There will be a lot of educational software.

The Apple IIe is a reasonable machine as long as you don't expect too much. As a first machine for grade school and high school students, it deserves serious consideration.

MINIMUM PROFESSIONAL QUALITY SYSTEMS

8-bit vs 16-bit One of the major choices you must make is whether to buy an 8-bit or 16-bit system. (There are 32-bit systems coming, too.)

This isn't as mysterious as it sounds.

The first microcomputers were 8-bit, which means that the machine processes 8 bits of information at a time. A bit is a simple yes/no; thus, an 8-bit "word" might be 01001100, which happens to be the representation of the number 28. There are 256 ways you can arrange 8 "0"s and "1"s, so the largest number an 8-bit machine can deal with is 255 (the numbers are 0 to 255). Since this is a severe limit, the 8-bit machines are taught to deal with several 8-bit words at once, but they can only get that data 8 bits at a time.

As you suspect, 16-bit machines can deal with 16-bit numbers. In theory, this allows them to be faster and more efficient; in practice, some 16-bit machines are slower than many 8-bit machines.

There are two advantages to 8-bit systems. First, they cost less. Secondly, there is currently more 8-bit software than 16-bit. In particular, there's a *lot* of software for machines which have a particular microchip known as a "Z-80" which run the operating system known as "CP/M." However, the trend to 16-bit is inevitable. The IBM PC and PCjr, the Tandy 2000, and the Apple Lisa and Macintosh are all 16-bit.

Many 8-bit machines can be upgraded to 16-bit capability. You're not necessarily stuck for all time. However, if you're at all interested in upgrading your system—and you will be if you use it much—then it will pay to be sure that the system you buy can be upgraded.

CP/M

The advent of the CP/M (Control Program/Microcomputers) operating system from Digital Research was a key event in the micro revolution. Prior to CP/M, most microcomputers couldn't talk to each other, much less run each other's programs, so that software written for one system couldn't be sold to owners of another. CP/M changed all that, greatly expanding the potential market base for software. This stimulated a positive explosion in microcomputer programming.

You can get good CP/M systems for under \$2,500, including software and printer. Incidentally,

be very wary about bargains. Some computers sound very inexpensive, but once you have bought one, you may find that you'll have to shell out another \$1,000 to \$2,000 for software to make it useful.

Other systems come "bundled," with software as part of the total price.

Of these, the most attractive (as I write this) is the Kaypro IV, which in my judgment offers the most computing power for the money. The Kaypro Company also offers the Kaypro II at even lower cost; it's worth the money, but you'll be better off coming up with the extra couple of hundred for the IV.

The Kaypro comes with an impressive bundle of software, including *WordStar* which is almost everyone's second favorite editor. There is also a "spreadsheet," the BASIC programming language, and a number of useful utilities.

The Kaypro screen is adequate but a bit small for day-in, day-out use. Although Kaypro does not offer adapters to allow you to hook it to a larger screen, there are a number of companies that do. Many writers buy Kaypro and arrange for a larger screen for eye comfort.

THE NEXT STEP UP

The Kaypro is a limited machine—not so limited that you will run up against its limits too quickly, but you will eventually come up against them. The next machine, one I can recommend from experience, is the Otrona Attache. This is the smallest and the lightest of the full system "portable" machines. It's a full machine, rather than a lap machine like the Radio Shack TRS-100.

The Otrona is expandable and upgradable. It comes with an impressive array of software, including *BASIC*, *WordStar*, a chart and graph program, and convenience utilities. The Otrona documents are quite good, making it one of the easiest machines to learn to use.

The Otrona's screen is very small, and you will need an auxiliary larger screen. The Otrona comes with an output adapter, so you need only buy a larger screen and plug it in. The Otrona's displays are very nice, and the machine has considerable graphics power. A number of writers prefer the Otrona to anything else they have seen; given a larger screen it can certainly serve as one's only computer. My Otrona goes with me to conventions, lectures, and pleasure trips, and I have written a lot of words on it.

I have no hesitation recommending the Otrona as excellent within its price range. You will keep it a long time after you have "outgrown" it, because it will serve as a portable.

ANOTHER STEP HIGHER

The next step takes us to a wide range of good machines, far more than I can review.

The real question is, is it worth it to go to the next step? The cost differential can be quite high. Oddly, as the machines get more expensive, the software that comes with them tends to be more limited. Thus you pay more for the machine, and you still don't get lots of software as part of the package price. This tends to make the total cost higher than you would have thought. On the other hand, the machines have fewer fundamental limits.

If you are a member of a government employee association, one of the best computer deals I know of is the Zenith Z-100. Some universities can also arrange spectacular discounts on the Z-100.

The Z-100 is the official microcomputer of the U.S. armed services. Zenith has sold a lot of them, and will sell more. Since there are so many out there, a number of programmers are writing software for it.

One advantage of the Z-100 is that it is a sort of hermaphrodite. That is, it runs both 8-bit and 16-bit software. If you get the Z-100, be sure to get the CP/M operating system; this runs both 8-bit and 16-bit software simultaneously, and you needn't know which you're putting into it. In addition, you can get the Z-100 with ZDOS, which is similar to IBM's PC DOS. Although there are a lot of programs for the PC that you can't get the Z-100 to use, they are not entirely incompatible.

The Z-100 has a built-in color display, a keyboard almost indistinguishable from the IBM Selectric, provision for expansion, and the noisiest fan I've ever heard in a computer. (Newer models seem to have a quieter fan.) We like our Z-100 very much, and many Z-100 users greatly prefer it to the IBM PC.

COMPATIBILITY REVISITED

We are now in the world of 16-bit machines. There is still more 8-bit than 16-bit software, but tons of 16-bit programs are being written. Most of that is for the IBM PC. Thus, your fundamental decision on a 16-bit machine is, PC compatible or not? And if PC compatible, how compatible?

In my judgment, a 16-bit machine ought to have *some* PC compatibility; at least there should be a good reason for it not to be. There is more 16-bit software for the PC than for everything else combined.

PC WORKALIKES

There are a zillion machines that proclaim, "Look, we look just like IBM, but we're not IBM. Isn't that wonderful?"

It's hard to tell them apart, and many of those companies will be out of business in a couple of years. There is no way the market can support so many.

Some IBM PC "clones" have special features.

EAGLE

The Eagle computers are in many ways better than IBM PC. They are faster, better designed, and cheaper, so that an Eagle with software generally costs less than an IBM PC without.

Eagles have mixed documentation. Some features, such as their editor, are well described. Other features are not described at all, so that the Eagle user tends to do original research on his or her machine. Eagle claims to be putting out new and better documents Real Soon Now; certainly the talent for doing so exists within the company.

We are very fond of our Eagle machines. The portable Eagle Spirit XL is 99 percent compatible with the IBM PC, but is faster. The Eagle 1600 is our favorite machine for developing software to run on the IBM PC and its workalikes.

CATCHING THE BUS

In addition to "all up" computers, which come complete with keyboard, screen, disk drives, and the rest, there are machines sold much as component hi-fi systems are sold. There's another similarity: The very best small computers are sold as components, but they're trickier to use and require that the user learn more about them.

My personal favorite machines use an internal structure known as the S-100 bus. These machines have great flexibility. You can add almost any features you like. They can be upgraded easily and cheaply.

I am writing this on a CompuPro Dual Processor, a machine that will run both 8-bit and 16-bit software. It is very fast, and almost indestructible. Ours runs 18 hours a day, and we haven't had a failure in two years.

The initial cost of a good S-100 system CompuPro is fairly high. After that, though, the cost of upgrading is quite low. This brings me to Pournelle's Law:

Iron is expensive but silicon is not.

In other words, if you have bought an S-100 bus system with its power supplies and motherboard (iron), then you can change its "brain" and other features by plugging in electronic component boards (silicon) for a few hundred dollars.

One of the first things the serious computer shopper should do is get a pamphlet called *Bits, Bytes, and Buzzwords* from a CompuPro Systems

Center. There is also a book available from Dili-thium Press with the same title and by the same author. Either is worth having. The pamphlet is an excellent introduction into the mysteries of microcomputers; the book is even more so.

By the time you read this, there should also be in print the *User's Introduction To Small Computers* by Jerry Pournelle from Jim Baen, Inc. I'm working on it, and should have it done Real Soon Now.

S-100 SPECIFIC ADVICE

If you do go with an S-100 system, get the Dual Processor. Alternatively, you may buy a system with a Z-80 board, and later convert it to a PC-compatible machine for a few hundred dollars.

Of the S-100 machines, I recommend CompuPro. It is reliable; I have had several CompuPro machines for years. I have had no trouble with them, but do buy from a systems center. Component equipment can be tricky. Remember: If you do not know what you are doing, deal with someone who does!

There's a lot of discounted equipment and software out there. When you buy at those discounted prices, you take your chances. You are buying without much support. If you know what you are doing or have someone who does, then you're all right.

If you do not know what you are doing, deal with someone reliable. If you're close to a CompuPro Systems Center, deal with them. They know what they are doing. They will sell good stuff, guaranteed to work (and work together), but the prices will be higher than you will see advertised in the magazines.

DUAL PROCESSORS

The 8/16 Dual Processor equipment—available from CompuPro, Zenith, or Fujitsu—will run both 8-bit and 16-bit software at the same time in the same machine, meaning that you have both worlds available. This gives access to a huge range of software.

Alas, not all of it will work. There are a number of well-known PC programs that you will not be able to run on a dual processor. On the other hand, continuous upgrades are being made. By the time you read this, there will be marked advances in S-100 PC compatibility, and in addition, there is an enormous wealth of 8-bit software that the PC cannot run.

FULL BUSINESS SYSTEMS

Some microcomputers are so powerful that it's hard to tell them from the larger machines known

as "minicomputers." The main feature of mini machines is that more than one person can use them at the same time.

This is all right for the minicomputers, but it is senseless for micros. Microcomputers are just not powerful enough to let a lot of people use them without slowing way down.

For the micro, the general principle is *one user, one computer*. That's what the micro revolution is all about.

One multi-user micro business system follows that principle. The CompuPro System 10, also known as "Shirley," has a CPU (Central Processing Unit, or "brain") for each of four users. Each user also has a bank of memory. A fifth CPU does traffic management. Each user has access to the disk drives, printer, and other expensive auxiliary equipment.

The CompuPro 10 is a lot of machine; there is little on the market that can touch it at its price. It is suitable for small business needs, such as inventory control, correspondence, accounting, payroll, etc. Mating such equipment to specific business needs is nontrivial; most firms will need good consultations.

THE OTHER STREAM

The IBM PC compatibles, and other machines that use the same or similar CPU chips, form the mainstream of small computer development. However, there is a large and healthy alternative: Machines with Motorola 68000-based systems are superior to the PC-compatible Intel 8086/8088 chip family.

The best-known 68000-based systems come from Apple.

APPLE FAMILY

The Apple Lisa was long awaited, but when it came out it was slow and overpriced. It uses novel control features and is worth looking at, but most analysts don't think it's worth what Apple charges for it. Not many were sold, so there's not a lot of software for the Lisa.

Although limited and overpriced, Lisa has some terrific features and employs some very advanced concepts. Lately Apple has begun to sell the Lisa without much software at a greatly reduced price. If you buy it without software you'd have to steal the programs from somewhere such as another Lisa because there are so few outside sources of Lisa software. I can't recommend that you steal software.

As I write this, Apple is pinning great hopes on their new machine called Macintosh. The Mac is

unknown to me, but many who have seen it have been highly impressed. There is not likely to be a lot of software for some time, although the Apple people are frantically trying to get some written for it. If you drive a Corvette, you might want to consider a Macintosh.

SAGE—68000 UCSD P-SYSTEM

The best 68000-based computers are made by Sage of Reno, Nevada. The only problem with the Sage is that to get much software for it, you must learn the UCSD Pascal operating system (called p-System). This is not necessarily a hardship. Many experienced computer people, including former *BYTE* Editor-in-Chief Carl Helmers, are p-System fanatics.

There is a lot of p-System software, including business programs. The Sage computer is very reliable, easy to use, and advanced; they are worth looking at.

Sage is also moving heavily into the Modula-2 market. In my judgment, the Modula-2 programming language will become increasingly important in years to come; Sage computers make excellent Modula-2 development systems. In short, the Sage is one whack of a good machine, and I know of no one who doesn't like theirs—but do look at the software available. There's nowhere near as much as you can get for PC compatibles, Z-100s, or S-100 bus machines.

CORVUS

A final serious contender in the 68000 family is the Corvus Concept. Corvus has made rapid advances in computer systems recently, and has developed impressive ways to get small computers to communicate with each other. It's a company worth watching.

THE BOTTOM LINE

Let's repeat the principles and add a few more:

1. If you don't know what you're doing, deal with those who do.
2. Buy more computer than you think you will need. You will run into its limits far sooner than you think.
3. Iron is expensive but silicon is cheap. Get a versatile system.
4. Be sure not to isolate yourself from the mainstream. The Intel 8086 chip family is good insurance; that's certain to take off. The 68000 may not.
5. Buy service as well as machines. The simplest service is to have two identical machines. In the case of S-100 equipment, the equipment

is modular, and can be replaced in expensive units.

6. Deal with established names. This doesn't mean you have to deal with IBM. What IBM has going for it is good service and marketing, but the prices are high and the equipment is not state of the art. It is the ultimate in PC

compatibility, of course, but you will pay extra for dealing with Big Blue.

7. The computer revolution rushes ahead. Provided that you act with common sense, the only really bad decision you can make is to wait too long before getting aboard.
Small computers really can make life simpler.

COMPUTERS FOR SMALL BUSINESSES

By JOHN DIEBOLD

In the film, *Modern Times*, Charlie Chaplin is a factory worker caught up in the monstrous machinery of an industrial age. The harried Chaplin is just another gear among gears, dehumanized and victimized by the machinery of progress.

There was a time when computers and automation in the workplace were viewed that way. Now, however, they are coming to be understood as precisely the reverse: Computers, especially the new desktop varieties, are freeing the worker from the machine pacing of yesteryear's jobs. In fact, their new role in business is aptly illustrated by another Charlie Chaplin: the affable, easygoing Chaplin of the IBM Personal Computer ads.

Because small computers are programmable, they can be adjusted to the workers' needs and not the other way around. This is really a first in the business world. It is also at the heart of the reason why these small wonders are stirring up a revolution in the way companies, large and small, do business.

What are the new technological artifacts of the small computer revolution? What tasks do they perform in businesses, from the proverbial Mom and Pop operation to the Fortune 500 company? How will they change the way companies do business, in both the immediate and distant futures? It is important to remember just how huge and cumbersome the first computers were to appreciate the sleek new models, some of which can fit comfortably into a human hand.

When ENIAC, the world's first general-purpose computer, was up and running in 1946, it filled an entire room and made a deafening racket. With 70,000 resistors and 18,000 vacuum tubes—which typically burnt out every few hours and needed replacement—the computer hardly seemed to represent the wave of the future. In fact, IBM decided, on the basis of market research in 1948, that there could be no commercial justification for entering the market as a vendor of these expensive digital contraptions. For the time being, it would stick with its electromechanical punch card machines.

Almost four decades later, IBM had clearly reversed that premature business forecast. In fact, in 1983, about 56,000 mainframes and 570,000 minicomputers were installed in the United States alone. And 2.4 million microcomputers were sold in that one year alone. The year 1984 is expected to be the milestone year in which microcomputer sales overtake mainframe sales for the first time. Nobel laureate Arno Penzias predicts that by 1986,

more microcomputers will be sold in a year than McDonald's sells hamburgers!

What all this means is a real shift in the ways computers are used in businesses. It used to be that data processing was performed in an isolated, glass-enclosed, raised-floor, specially air-conditioned room, from which highly trained technical personnel delivered information services to end users—the noncomputer professionals in the company. But microcomputers change the balance of computer power by putting friendly, accessible machines right at the end user's fingertips.

In fact, "end user" is becoming an obsolete term: Rather than beginning in the computer room and ending at the noncomputer professional's desk, computer power now begins and ends anywhere and everywhere a small computer opens a window onto the information resources of the company.

But what are small computers used for? While "You name it" may sound too evasive, that is really the most precise answer one can give. Rather than the machine determining the task that is performed, the user can determine the application. The small computer is *programmable*, or malleable to the user's needs, and therefore offers a means of unleashing the worker's creativity in unprecedented ways.

Small computers are becoming friendly assistants that amplify the individual's knowledge and extend his or her capabilities. Let me give a few typical examples:

With a decision support system, or DSS, the executive of a large company can use a small desktop computer to tap into the information resources of a large central computer. This means he or she can have up-to-the-minute reports, charts, and detailed information on the performance of various divisions of the corporation. A DSS might offer a "What if" capability, allowing the executive to test various assumptions with real data rather than making "seat-of-the-pants" decisions.

This is a big improvement over the days when an executive would ask a data-processing manager for a computer-generated report and then wait days or even months to get it—only to receive a voluminous printout with inscrutable and largely useless data!

For other professionals in the company, the personal computer offers a similar window onto the information resources they need for their specialized tasks. A personnel manager can call up employee records, an accountant can "access" the

dollars-and-cents figures. In addition to tapping centralized information, workers can also share information with each other through electronic mail, or computer-generated messages sent to electronic mailboxes that the receiver can call up and read at leisure.

Database services extend the user's information grasp even beyond the stores of the corporation. Using a modem, which converts computer signals into a form that can be transmitted over phone lines, a personal computer user can dial into national electronic information services like The Source or Dialog and retrieve stock market quotations, read abstracts of magazine articles, or post bulletins on electronic bulletin boards.

CAD/CAM systems—computer-aided design/manufacturing—let the designer of a new automobile test various designs on a computer screen, rotate them visually, and adjust them, without the tedious and time-consuming task of drawing and redrawing detailed designs.

Ideally, microcomputers will become part of integrated corporate information systems in which traditional data processing, office automation, telecommunications, factory automation, and professional desktop computer users are all melded into one. Under this holistic approach, the whole is greater than the sum of its parts! This is an extremely complex undertaking—especially in light of all the political factions involved—and very few large companies have accomplished this technological synthesis. Yet integration is where the real promise of small computers lies.

Even the smallest of companies, down to the self-employed professional, can benefit from the many uses of small computers. Popular spreadsheet software packages make it easy to balance the books; using such a package, a person can adjust the numbers in one column and have all the other columns automatically recalculated—with effortless precision.

For the small-business person, personal computers can keep track of investment portfolios, maintain schedules and mailing lists, access electronic news and other information services, store files, and track orders and invoices. Some software packages offer modest database capabilities.

For writers—and a wide spectrum of professionals who spend at least part of their time writing—the small computer is a boon: With one of the sophisticated word-processing packages available today, it is possible to edit and reorganize a draft without tedious and time-wasting retyping, freeing the writer for the more creative aspects of the job. Word-processing packages can automatically

index and footnote, check the spelling, assign page numbers, and print in a variety of formats.

And portable computers, some of which fit neatly inside a briefcase or under an airline seat, let businesses of all sizes carry the computer to where the job is. A salesperson on a client's premises can use the portable computer to call the company for a price quote and give the client an on-the-spot estimate. A repairperson performing a difficult machine repair can use a handheld computer to retrieve instructions from a tireless electronic tutor. A reporter for a newspaper can transmit a story directly from hotel room to the news office back home. And the traveling businessperson can use idle time at airports and in taxis to tap out memos, notes, and random thoughts on a portable computer—and have them printed out at any number of locations.

In addition to assisting companies in performing business as usual, the small computer much more importantly changes the way business is done altogether. When a bank can provide banking services via a personal computer in the office or home, it is changing radically the nature of its business and the criteria of competition in the banking industry. Whereas banks used to compete based on the number and convenience of their branch locations, the electronic age makes the location of a bank largely irrelevant—it will now be judged on the basis of its electronic services.

Publishing, too, is going through dramatic changes while facing competition from unexpected new sources. Rather than reaching its customers principally at newsstands or on bookshelves, the industry faces a whole new market with the advent of "videotex"—interactive information services available via small computers. While videotex has only been practiced in limited experiments in the U.S., it is clear that the future of publishing encompasses much more than the written word.

Virtually all industries and services will probably go the way of banking and publishing as small computers help change their markets, their products, their sources of distribution and supply, and ultimately the parameters of competition. Already, dozens of everyday products, from sewing machines to automobiles, are incorporating the intelligence of microcomputer chips.

For the individual, the small computer means big changes in where and how a job is performed. Personal computers make possible a new working arrangement known as telecommuting, whereby the worker can do his or her job from a pleasant seaside resort or a mountain retreat, and transmit doc-

uments electronically to the corporate headquarters. Ideal for creative and self-motivated individuals, telecommuting lets the employee work when it is most convenient and appropriate; a night person can work from midnight to 8:00 A.M. if he or she so desires.

In an age of international competition, businesses have much to gain by using small computers to unleash the productivity of their workers, and to promote a work environment conducive to creative and innovative people.

So many changes in the small computer field are unfolding that it would be impossible to even define the current state of the art, but a few trends are clear. The technology is progressing toward access methods that are friendlier and more natural than the typewriter keyboard. Already, we are seeing wider use of the handheld mouse, which lets the user point electronically at what is needed. Touch-sensitive screens are a move in the same direction.

Personally, I am waiting for the day when I can speak into a computer with the ability to recognize natural spoken language. (Systems today still don't communicate in anything resembling everyday English!) For example, I might ask the computer to write a polite letter declining an invitation to speak at a conference. The computer would then sift

through its memory for previous correspondence and synthesize a letter in my personal style and diction, saying, "While I admire the XYZ organization and support its goals, I simply have a previous engagement, etc., etc."

From first-hand contact with researchers in linguistics and artificial intelligence, it is clear that such systems are not far away. Even more complex systems are coming into sight as scientists draw parallels between computer storage and the way genetic information is stored and processed in human cells. Biological computers hold out the possibility of miniaturization that is light-years ahead of the densities that are possible on silicon wafers.

Personal computers are still somewhat awkward for people who have never learned how to type, but the models on the market today offer countless business opportunities to the many information workers—the managers, educators, lawyers, accountants, writers, consultants, secretaries, researchers—who are already the largest segment of the American work force.

Today's small computers are only the first ripple of a dramatic revolution in the way businesses will organize, manage, and motivate their workers in the coming years.

PERSONAL COMPUTER FUTURES

By CARL HELMERS

The much maligned year 1984 arrived as an anticlimax. Contrary to dire predictions, we now live in an era of freedom and its corresponding wealth—including an ever-increasing wealth of options in the personal use of modern technology. The key to modern technology is the computer. The integrated circuit has made the computer inexpensive and cost effective. Since the first personal computers arrived as kits in the mid-1970s, the micro has turned the traditional computer world upside down. Computer shops have sprung up in every other shopping center and in all but the smallest towns. New technology has made it possible to mass produce devices formerly seen only on large computers, and it has also made them far more reliable.

The personal computer has had tremendous impact, in myriad forms for many purposes. Tens of thousands of individuals are now buying powerful computers in department stores at prices well under \$1,000. They are used for the education and entertainment of children and adults, for personal financial calculations, and as the modern equivalent of the old-fashioned family typewriter.

Thousands of business and professional people are getting acquainted with professional quality personal computers at their local computer store. These usually sell for prices starting at \$2,000, for which the purchaser gets a much more reliable and capable computer than those now available in toy stores. A multitude of professionally oriented software packages then turn these full-scale general-purpose computers into valuable business tools. And across the nation, the purchasing departments of innumerable large companies are trying to make sense of all the advertisements for hardware, software, environments, and so on.

In a sense, the computer market closely resembles the world of automobiles. The consumer computer is the mass-produced automobile of the computer world. It is widely available and relatively cheap. The professional-grade personal computer is the light truck or van, widely used by small businesses. Many individuals buy them as well. The original large computers are the 18-wheelers of the computer world. They are almost exclusively used by businesses for heavy work.

The era of the personal computer has irrevocably arrived. What will follow? Let's explore some likely futures, near and far, examining trends for consumer and personal computers, hardware, and software.

The hardware field has undergone a dramatic transformation in the last ten years, with the microprocessor chip appearing as the central and essential engine of the personal computer system. This is true whether we are talking about a \$29.95 drug-store computer or a \$10,000 professional personal system. Every personal computer has one or more of these complex large-scale integration chips. The differences are all a question of price versus performance.

In 1984, the variety of standard microprocessors for personal computers is considerable. They process data in chunks from 8 bits to 32 bits at a time. They are able to address maximum memory sizes from 65,536 bytes to greater than 16 million bytes. And they use internal clock rates from 1 million cycles per second to greater than 2 million cycles per second. What does this suggest for the user? It means that we can spend our money on widely varying degrees of performance.

Today's microprocessors for personal computers reflect the course of technological evolution taking place since the mid-1970s. The high-performance, high-price processors are the latest designs from the semiconductor foundries. The most widely sold of today's consumer computers still use the 6502 and Z-80 designs that were revolutionary products nearly a decade ago. These were the first successful NMO5 microprocessors, a technology that is already being replaced for some purposes by still newer ones.

Most professional personal computers use the newer 16-and 32-bit microprocessors that have arrived more recently. The process of creating higher and higher performance in microprocessor designs still continues, of course. In the near future, 32-bit processors like the Motorola 68000 and variations of the 16-bit Intel 8086 family will abound. The 68000 is already used by the Apple Lisa and Macintosh machines, the Sage IV, and a host of professional work station personal computers. The Intel 8086 processor family is used by the IBM PC and the innumerable PC clones now available.

Microprocessor chip designers never stand still. Take a snapshot of the available processors in any given year, and the next year's processors will prove to be higher performing, easier to use, or superior in some other respect. Thus we now see the "CMO5" low-power integrated circuit process being used to create new versions of older chips. Low power consumption is essential in the popular battery-operated portable computers. These CMO5

chips are functionally identical to the older NMOS designs they replace, but they use much less precious electricity. So, when you buy an Apple IIC portable, remember that the internal CMOS 6502 that makes it work is functionally identical to the earlier generation NMOS version of the original Apple II, the Apple II+, and the Apple IIe—yet it is a major technological advance.

The next generation of superperformance 32-bit processors following this low-power trend will likely be done in CMOS. Here the requirement is to keep the chips cool. When the chip gets sufficiently complex, it becomes impossible to cool it fast enough. CMOS chips, on the other hand, are more efficient because less heat is given off when similar functions are performed at the same speed than with other design methods.

Equally important is a major trend toward the development of specialty microprocessors. Today's consumer computers and video games would be impossible without the first generation of "sprite graphics" integrated circuits. This graphics revolution extends further. On their way are "graphics engines" that will produce higher resolution displays and more affordable hi-resolution graphics.

This need for separate processors, used to speed up operations, will not be confined to graphics. Many of today's computer designs use the "co-processor" integrated circuits designed to crunch on numbers or do searching operations efficiently. Specialized processors, primarily used in the realm of artificial intelligence, will begin to influence personal computer designs over the next few years.

The evolution in the design of memory circuits is intertwined with the recent developments in microprocessor design. Back in 1972, we were lucky to see 256 bits stored in one chip. Today's latest designs pack 256,000 bits into one chip—a thousand-fold improvement in just over a decade.

The future will see ever more bits per package. IBM will soon be producing chips with a million bits. This trend will continue for a few more years, but will eventually reach an upper limit based on the subtleties of semiconductor engineering and solid-state physics. The largeness of practical integrated circuit chips and the smallness of perfect patterns of circuitry on these chips are limits that have yet to be found.

Memory is required to do interesting things with computers. I once had an intriguing phone conversation with an engineer from Missouri. He informed me, presumably with a straight face, that all the

memory a personal computer would ever need would be 1,000 bytes. Even in 1975, I knew that he was dead wrong—simply to edit a decent size text requires several tens of thousands of bytes of buffer memory. I had already been gobbling up several hundreds of thousands of bytes in my previous mainframe computer experience. Back then, though, large memory for personal computers was very expensive. Memory is much less costly today. It has become accepted practice to have from 64K to 128K on most personal computers. By 1986, the "normal" supply of memory in a personal computer will be close to a million bytes of semiconductor RAM.

Decreasing memory cost has also resulted in tangible design benefits. Today there are myriad ways to use a semiconductor "RAM-disk" drive. This memory process simulates the operation of a hard or floppy disk. But since the simulation is entirely based on memory, there are none of the mechanical delays associated with either a hard or a floppy disk. Of course, with RAM-disk simulations we risk the possibility of losing data when power fails. But we gain significantly in the speed of execution for our programs. In most computers the RAM disk simply requires a large amount of memory and a suitably configured operating system.

Mass storage is essential on any computer. This storage is used for random access of programs, random access of data, and archival storage of data. There is little new and exciting about the need for this resource in computing, but the methods of attaining it vary widely.

Toy computers use cassette tapes. Many of the mass-market personal computers use ordinary audio tape to store data. This is cheap but terribly inconvenient. One recently introduced personal computer went one step further, featuring a digital cassette tape for mass storage. This was not a great improvement. Tape is inconvenient because it is serial; there is no way for a tape to play back data at point A and at point B without covering all the data in the middle. For convenience of mass storage, we need random-access media.

Personal computers and low-end minicomputer systems have traditionally achieved random-access mass storage through the flexible (i.e., floppy) disk drive. When personal computing began in 1975, the typical floppy diskette was 8 inches in diameter and held only 256,000 bytes. Disks shrank to 5¼ inches in diameter and 140,000 bytes with the introduction of the Apple II floppy disk, a landmark disk designed by Steven Wozniak. With to-

day's IBM PC-compatible drives, the same 5¼-inch diskette can hold as much as 800,000 bytes when recorded in the double-sided, double-density mode.

The future holds out the probability of smaller, approximately 3-inch diskettes. The 3-inch disk drive has yet to establish itself, in part because there are at least three competing standards, but it will eventually be chosen for most new personal computer designs. The reasons are simple: The 3-inch disk drive designs will all attain much higher recording densities. The capacity of tomorrow's 3-inches is likely to exceed 2,000,000 bytes.

But even tomorrow's three-inch floppy disk will be slow. Mainframe computers have always relied on removable-media hard disk drives and computer tape drives for large, archival storage. To date, they are almost unknown among micros; floppies are the removable-media disks of the personal computer world. But with personal computers, something new has appeared: hard disk drives with disks mounted permanently in place.

At a premium price, this particular drive currently provides 5 million or more bytes of fast random-access disk storage. Our hard disk files are permanently connected to the machine unless software removes them, purges them, or destroys them inadvertently. Today's personal computers can be delivered with a hard disk that stores an excess of 10 million bytes—and at reasonable cost.

Imagine what one could do with a 100-megabyte hard disk drive? They will soon be available. At a recent conference, an engineer who specializes in hard-disk research made an interesting comment about today's personal computer hard disks: "Not bad for a technology that is only ten to fifteen years out of date." This same researcher fully expects a thousandfold improvement in hard disks for personal computers, since such sophisticated knowledge has already been worked into hard disks for large computers. Similar improvements will come to the premium personal computer market as larger available storage. For the less expensive systems, one can anticipate cheaper hard-disk drives in the 10-megabyte range.

One of the main uses of memory in advanced graphics systems is to store and manipulate the contents of a display. There are two fundamental technologies now in use. There is the old standby, the color or monochrome cathode ray tube (CRT), which has been around for over 20 years. And recently liquid crystal displays (LCD) have become widely available. Other display technologies in limited production at present include electroluminescent panels, plasma displays, and several others. Over the next two or three years, we will see an

increasing use of liquid crystal displays, especially in low-power portable computers. The number of picture elements possible on an LCD device will continue to improve; the standard 24 lines by 80 characters is already available in prototype units.

Another promising graphic device is the electroluminescent display. This kind of display is currently in production in only one personal computer, the portable Grid Systems Compass. It is far superior in legibility to the equivalent LCD display, a flat panel replacement for the cathode ray tube.

The cathode ray tube will remain the only method available for color display for some time. But when the TV manufacturers have developed an inexpensive color flat-panel display, you can bet that computer makers will not be far behind. The uses of inexpensive color graphics in personal computers are now growing rapidly. Color is a valuable way to highlight different portions of a picture, whether the picture is a graphic image or a written text.

Pointing devices are becoming more and more common. The pointing device is a way to move objects about on a display screen, or select objects from the screen. Using the pointing device is a more natural way to do many operations than through the keyboard or a command language.

The hardware of pointing devices comes in many forms. One computer company, Hewlett-Packard, has introduced a computer that responds to a finger touching the screen. A number of software companies are adding such electronic hardware to their offerings as "mouse" pointing devices. The old reliables of video arcades—track balls and joysticks—are often used. All these pointing devices accomplish the same goals as the arrow keys on a terminal keyboard; they serve to indicate a direction and distance to move the cursor on the screen. As methods of interacting with programs, such pointing devices are among the best. The basic mouse is an object that can be grasped with a hand and moved in any direction on a horizontal surface. The direction and magnitude of motions control what happens on the screen. Now that Apple Computer has hitched its star to the mouse, we can expect many more companies to introduce mouse-style pointing devices.

Every computer needs a printer if it is to be used for software development, word processing, or any application where hard copy on paper is necessary. Every business use of a personal computer requires a printer—for printing business forms as well as for ordinary word processing.

Printers have improved greatly since the first personal computer appeared. This is reflected in price drops due to mass production. It is now possible to

spend \$500 for a high-quality graphic dot-matrix printer that was unheard of ten years ago and might have cost \$5,000 only five years ago. Today they are available in every computer store and many department stores. This trend will continue. Witness the recently announced Hewlett-Packard ink jet printer and its incredible price tag of \$495. Various plain-paper copiers are converted into combination laser printers and copiers for the office. Personal computer laser printers cannot be far behind.

The revolution in electronics and computer technology is by no means confined to the major units of personal computer systems. For example, there are bound to be more and more exciting ways to unite the personal computer and the telephone. One example is the computer phone dialer connected to a private database for automatic dialing. Today's modems can do this, but tomorrow's personal computers will have this feature designed into them without the need for accessories.

Graphic input devices are important for those who do graphic processing—the art of painting and manipulating scenes in memory coupled to high-resolution displays. Similarly, voice input will improve greatly over the next 10 to 15 years. This whole field of alternative input methods is ripe for innovation and application.

The combination of hardware and software into a working personal computer is a design goal that does not respect the boundaries between hardware and software. It is impossible to design and market a computer without some expectation of how it will be used. The use of the personal computer is impossible without a hardwarelike piece of software, the operating system. The operating system comes with the typical personal computer, built into read-only memory, stored on a hard disk at delivery, or loaded from a floppy disk. It is this program that defines the computer's operating environment—how it interacts when power is first applied to the machine.

In the personal computer of today, the operating system depends upon many factors. For the lower priced consumer computers, there is no choice at all. "You pay your money and . . ." In the group of serious personal computers ranging in price from several thousand dollars and up, the choice of operating systems is wide and varied. There are CP/M, MSDOS/PCDOS, the UCSD p-System, and UNIX, as well as the many varieties of one-manufacturer operating systems that lock the user into one particular computer.

The advent of machine independent software is finally being seen in the marketplace—operating systems and methods of programming that allow

programs to run on many different computers. By default, all the IBM computers using PCDOS achieve this through the widespread cloning of IBM PC hardware. By conscious choice, the use of the UNIX operating system achieves this over a broad array of different 16- and 32-bit microprocessor designs.

Where will it all take us? Today's personal computer market is but a taste of a high-technology world of the future. The question of systems is a very divisive issue among software and hardware engineers. The end user should never have to deal with the details of operating systems; this user should be presented an operating environment that is friendly, interactive, and useful.

We're starting to see a trend toward programs that create an integrated user environment—programs that should have been delivered with the computer right at the start. With a popular program like *Lotus 1-2-3*, the question arises: Should the computer be delivered as a 1-2-3 computer or as a general purpose computer that can run 1-2-3? The environments possible in software are intimately connected with the hardware on which they must run.

Imagine for the moment a method of feeding data into a computer without the claptrap of a typewriter-style keyboard. Would today's personal computer operating system even work in such an environment? What would be the appropriate command structure? Many such questions have already been answered in the marketplace for products that people may not even think of as computers. A video game, for example, has an operating environment with minimal input from any kind of keyboard. The engine computer of a modern automobile does not even know what a keyboard is.

In the near future, we'll be seeing more and more ways to use these alternative input devices for the personal computer. One company already sells a way to enter hand-written data into an IBM PC. If you buy the Pencept board, suddenly you can work with *Lotus 1-2-3* by writing on a digitizer pad. One can do an enormous number of things with such graphic inputs as the Pencept software/hardware combination. Much-improved hardware for this task will soon emerge from the research and development labs.

Going even farther into the future, consider the long-sought goal of the robot servant. Here is a personal computer par excellence—the C3PO of *Star Wars*. I cannot imagine a more fully developed personal computer, a mobile computational database at my beck and call. Is it possible? It is only a matter of time and technology. We see the first glimmerings of the robotic revolution even today.

WHY AREN'T THINGS WONDERFUL YET?

BY TED NELSON

For 14 years, from 1960 until 1974, I told everyone I met how wonderful it was all going to be when computers became personal. I wrote articles about this, and a book.

All during the sixties I made speeches about how computers should really be personal, not corporate, and how wonderful the world would be after that change came.

Then, at the end of 1974, there was announced the first computer that can be called "personal"—the Altair. And then came many brands and computer stores and floppy disks and personal software and dozens of computer magazines and a billion-dollar marketplace. And I, for one, am so far enormously disappointed: things aren't nearly so nice as I expected, at least not yet. But in many ways it will get much better.

At least a few good things have happened.

The computer centers, with their red tape, tinpot dictatorships, and monopoly control of computing in the sixties, have had that monopoly broken. People can get access to computers without going through the rules and unpleasantness of the computer center.

People know now about interactivity and what interactive systems mean.

People have begun to learn about personal uses of the computer—although to use them personally is still hard, the software being complicated and Balkanized.

People have begun to understand the computer as a palette for human creativity: that numerous forms of creative endeavor take new form, or even exist uniquely, through the computer. Now we can do new forms of music; graphic arts of kinds never before seen; games of new kinds never seen before; new forms of teaching and presentation.

But even more, the design of the art and magic of interactivity itself—response to buttons and joysticks, the new tricks of making ideas spring alive on the interactive screen—all this is very new.

People now know about interactivity, and know (at least dimly) about the design of interactive systems.

But the whole point of computers, as far as I am concerned, is that they should make life better. This has several aspects.

Computers should bring simplification. It should be easier to manage our lives and our affairs.

Computers should bring clarification. In whatever we do we should be able to highlight our understanding, mark the key passages, figure out what's going on more easily.

Computers should bring *etherealization*, a Bucky Fuller word meaning the opposite of "make cumbersome." Etherealization means making things smaller, lighter, more efficient—and getting them out of the way.

Computers should bring greater grasp—both grasp of thought and grasp of doing. Not only should they help us get a grip on our lives; they should help us see, understand, visualize, and analyze, presenting many different views for our study, helping us to a wider and deeper understanding of whatever we use them to view—a wider and deeper understanding of the world's problems, for example.

None of these improvements has occurred yet. Instead the small computer has brought a torrent of complication.

Damnable complication is the order of the day.

Complications are separate and unlike. It's much worse than the New York subway system.

Incompatibility. Practically nothing fits together. For the most part, accessories fit only the specific machine they are sold for, printers and monitors being fortunate exceptions.

Fragmentation and triviality. Tiny pieces of things, incompatible junk in both hardware and software, are still common.

Now you can get capable things, but they're incompatible.

Programs are incompatible. Unfortunately very little can be done about this.

There is no mix-and-match of programs. You cannot take parts you like from one program, say, a word processor, and combine them with parts you like from another, even of its type.

There is no mix-and-match of data. You cannot move a file from *EasyWriter* to *WordStar*; it is not merely that they have different storage formats, but that they keep track of different things. The data of one is very different from the data of the other.

In general, all forms of data for a given purpose are incompatible. It would be very nice to have some kind of a universal storage system—but none is as yet commercially available.

We want to be able to exchange and combine things easily.

We want to be able to save things easily. But storage is a mess. People want to store a great deal, which is fine, but in the current marketplace that boils down to the question of which disk should I buy? But that is like telling someone who wants to get across town that he has to buy a car. Presently there is no well-formed remote service

providing storage, except through conventional time-sharing—a costly and inefficient way to handle the problem.

“Networking” and “conferencing” are becoming popular—but they all work under different sets of complicated rules.

For years I have been saying that computers should be simple and learnable in ten minutes, and nobody seemed to understand what I meant.

The purpose of computers is human freedom.

The true use of computers has always been personal.

Using a computer should always be easier than not using a computer.

Finally, in 1983, I could point out what I meant, because Apple brought out the Lisa.

Here is a machine which you can learn quickly—starting to perform effective work in minutes, becoming fairly expert at a given application in a matter of hours.

True compatibility is not here yet. No other computer can run the programs a Lisa runs or read the data a Lisa stores.

Yet we may expect cheaper and more comprehensive, broader software. Spreadsheet, Lisa, and Lotus are the beginning.

One key to the problem of software piracy is to make programs so cheap and instantly available that users don't bother to keep a copy. I believe that software vendors would profit more, not less. But that essentially means a big archive, and the ability to dip into it easily and combine parts easily.

It will be the most ethereal system yet developed.

In addition to programs, our facility will offer unusual capabilities for comparison and pluralistic understanding.

It will be a universal repository, available to everyone as a paid service from their computers. Thus it will offer public-access storage. (Simple-minded forms of public-access storage are available already, but only through conventional time-sharing systems, more suited to general applications than to the complex and special forms of storage that are really needed.) The system is thus brought into line with the subtle structure of the existing literary system—which conventional storage and time-sharing do not relate to.

This network offers facilities for detailed comparison built in at the data-structure level. That is, if two different versions or documents are made from parts of the same original, it will be easy for the user to see these parts side by side to compare the two versions or documents.

In other words, what is needed is a form of stor-

age; but one which makes possible a wholly new literary genre, and which makes possible in turn a very great dream indeed.

This is the dream of one great publishing repository, available to all. Not only will conventional text and graphics be available, but anyone may publish links between these documents, links and commentaries of any type. Moreover, the system will offer instant revelation of the origins and interconnections of all quoted and borrowed things.

This is a literary system to be sure, playing on the unsuspected elegance of literature—a debugged system that works for many purposes.

Literature may contain many points of view. All views are expressed by those who believe in them, which is the ideal way to have them expressed. All views are presumed legitimate. The old is kept, the new viewpoint improves it; until the old is rediscovered and reinterpreted, making it new again.

The mechanisms of citation (indicating where you got an idea) and quotation (using the original believer's original phrasing, and indicating where you got it) are well-honed.

We preserve these mechanisms, but extend them: If everything is available, everything being cited or quoted is also available (including inter-comparison facilities).

This cannot be a charity. To become universal, it must be a shared facility available and potentially profitable to all. Thus we have built in one more literary tradition, the royalty, assuring that those creators doing popular and useful work are rewarded. The royalty is on every byte, and it applies for each occasion a byte is transmitted, being billed to the user receiving the data and incrementing the “cash register” of the given document.

Such a system gets around the disjointed character of conferencing and network conversations and bulletin boards. Since it is a storage system that can grow indefinitely, it can be treated as an elastic archive, and everything can remain instantly available—presuming that someone is paying for its storage.

Since royalty is paid only when bytes are sent to users, we have one minor addition to the existing copyright law: Publishers on this system will be required to allow unrestricted quotation of what they publish. But this is worthwhile to them: They automatically receive a royalty for each quoted use; nothing is ever misquoted, since it is copied from its original location; and nothing is ever out of context, since the user may branch at once to the original context if he or she desires.

It is designed for perpetual expansion.

MICROS UNDER \$1,000

ACORN

The British Broadcasting Corporation's Acorn computer was introduced into the U.S. market in 1983 after earning over 85 percent of the British educational computer market. The Acorn seems destined to play a significant role in American as well as British education. The Acorn is unique among microcomputers in that it was designed specifically for educational applications; business or personal uses were secondary—just the opposite of almost every other popular personal computer.

The Acorn is a remarkable machine that includes myriad impressive features at a very reasonable price. But while the spiffy graphics, built-in speech synthesizer, and plentiful educational software are likely to make any computer-loving teacher's heart throb, most business people probably won't get too excited about it. They will notice the absence of a ten-key numeric pad and the lack of business software. The manufacturer's literature boasts that the Acorn is the only computer designed by educators for educators. However, business applications are possible with the addition of an optional Z-80B processor, which transforms the Acorn into a CP/M compatible machine.

The Acorn offers a range of built-in features and expansion potential that rivals any other computer in its price range. The system is based on the 6502A microprocessor, which operates at 2MHz—fast for a 6502. The operating system, BASIC and assembly language, and word processing are all built into ROM as standard features. Also included as standard are disk interface, both Centronics parallel printer interface and RS-423/232 serial I/O, speech and music synthesis, RGB video interface, RF modulator for using the computer with a regular TV, networking, 32K RAM, and add-on slots for expansion. Also included are four analog inputs for use with such items as game controllers and light pens.

The keyboard is a 73-key full QWERTY typewriter layout, including ten user-definable function keys, four cursor control keys, two-key rollover, and auto-repeat features. The keyboard is fully buffered.

The system is often sold with a 13-inch RGB color monitor. The normal text display is upper- and lowercase, 80 columns by 25 lines. However, any size of print, from 16 columns to 132 columns, may be selected. Any of 16 colored backgrounds may be chosen by the user. The high resolution graphics give 16 colors in 640 × 200 pixel configuration.

The Acorn may be had with either one or two 5¼-inch disk drives. Each drive has a 400K formatted capacity. A 300- or 1200-baud built-in interface with motor control for standard cassette recorders is also included.

A four channel built-in music synthesis system feeds a built-in speaker. The built-in speech synthesizer uses a "phrase-oriented ROM," called a PHROM, to allow the user or packaged software to produce speech. The Acorn, naturally, speaks with a British accent, but speech quality is good.

The Acorn's built-in networking capacity, called Econet, is simple to use, but surprisingly sophisticated. Up to 254 Acorns may be linked using standard two-pair telephone wire. The network allows machines to share disk drives, printers, and other accessories. Data can be transferred from any computer on the network to any other quickly. The screen display of any one computer may be "dumped" to another in a matter of seconds. Special commands provide security to lock software to restrict access or prevent changes or deletions.

The integration of the built-in software is impressive. For example, the user may switch from BASIC to word processing directly to facilitate editing of programs. The accompanying user's manual documents the built-in software better than most manuals and includes a tutorial on the BASIC language.

Over 200 integrated packages of "courseware" are available, including not only software programs but teachers' guides, and class activity materials. Subjects range from elementary language arts to advanced genetics. Most of these were produced in Britain. BBC software may be backed up three times, after which it refuses to copy. Recognizing that Americans won't care much for the British flavor, the BBC is encouraging second party producers in the United States to develop additional materials while it is busy translating its own British software into American. Several major software producers including Spinnaker, SRA, Krell, MUSE, Educational Activities, and Encyclopedia Britannica have signed contracts to produce Acorn software.

The Tube is Acorn's term for its expansion system. A second 6502 microprocessor may be added to give the Acorn an additional 64K of RAM; a Z80B co-processor may be plugged in to provide CP/M compatibility; or a NS 16032 16/32 bit processor may be added to provide Microsoft XENIX compatibility and 256K RAM.

The base price of the computer is \$995 suggested retail; it is not likely to be discounted much. A price of \$2,495 is quoted for a "best of every-

thing" system, including the computer, an RGB color monitor, and a dual, double-sided, double-density disk drive unit.

The Acorn is indeed an impressive machine. The graphics resolution and color saturation provided by the RGB color monitor is excellent. The processing speed of the computer is very fast. This is especially noticeable in animated graphics and in word processing. The music and sound effects are about on a par with the Apple II or Commodore 64, but are easier to produce with the built-in software. *BBC BASIC* is much like *Microsoft BASIC*. Users of computers employing *Microsoft BASIC* should have no trouble in adapting to it. The keyboard feels good and is well arranged.

On the negative side, the disk operating system is slow. The built-in word processor, *VIEW*, is easy to use and adequate for most users but is not as powerful as some of the more sophisticated word processors available. Dealer support could be a problem for the Acorn user, as there are not as many trained dealers or technicians for this as for other popular micros. However, Acorn has obviously made a serious commitment to the American market and is rapidly adding dealers. The software base is not as extensive as any of the big three in educational computing—Apple, Commodore, and TRS-80—but it is growing and BBC seems to be stressing quality.

It seems likely that the Acorn will soon be a significant competitor for the education market. A school district with a \$30,000 budget for microcomputers could purchase 17.2 complete Acorn systems vs about ten Apples or eight IBM PCs similarly configured. Even without most of the optional peripherals, the competitive brands still cost more. Schools will soon discover this. Besides, all the built-in features are nice and save the buyer a lot of trouble in ordering separate items.

The Acorn is a nice machine. If they could just get rid of the British accent. . . .

Acorn Computers Corp., Base price \$995; with RGB monitor and dual disk drives \$2,495

APPLE IIe

Conceived in a garage over seven years ago, the Apple II has evolved from an electronic novelty appealing mostly to hobbyists and engineers to a vital, productive tool found in homes, businesses, and industry and used by over a million people ranging from preschool tots to corporate presidents.

Criticized constantly for its 40-column display

and teletype-style keyboard, the Apple II nevertheless endured. Its numbers grew by the tens and hundreds of thousands, and so did the availability of software. Crude by today's standards, the early word processor and accounting packages managed to get the job done. As the years passed, the number and quality of programs increased, and the Apple itself was revised and re-revised. Plug-ins and add-ons soon flooded the market: language cards, printer interfaces, 80-column display boards, coprocessor boards, clock cards, keyboard enhancers ... just when one thought everything possible had been invented, along came something new.

No longer in production, the Apple II/II+ has been replaced by the Apple IIe. The "e" means enhanced, and while the most obvious change is the improved keyboard (more on that later), a look inside the familiar, rugged beige structural-foam case tells the real story. At first you might think something got left out in the final stages of production; but what you really see is the result of modern technological advances in integrated-circuit design. What used to require 109 integrated circuit chips in the old Apple II is now handled by a mere 31. Instead of 24 16K memory chips used to yield 48K of memory, the IIe uses only eight 64K chips to give a full 64K of user memory as standard equipment. All of this results in reduced power consumption, less heat, and vastly lower RF interference, the wavy lines on your neighbor's television set.

The IIe's keyboard is a major improvement over its predecessor. Modeled after the Apple III keyboard, sans numeric keypad, it is about as close to an ideal typewriter board as you can get.

The population of keys has grown from 53 on the Apple II to 63; the additional keys include TAB, DELETE, four cursor control keys, Caps lock, special symbols that were either difficult to produce or completely unavailable on the II and II+, and two special programmable function keys labeled with a solid Apple and an outlined or open Apple. Missing is the Repeat key, since all keys are now auto-repeating after a 0.9-second delay. The IIe now produces upper- and lowercase letters without the need for add-ons, and all 128 ASCII characters can be directly input at the keyboard.

The Reset key has been moved to avoid possible accidents, although in later versions of the II, this problem was eliminated by requiring both the Control and Reset keys to be pressed at the same time. In the IIe, this also holds true, and if you simultaneously depress the Open Apple, Control, and

Reset keys, the computer will execute what is known as a warm start. This does the same as shutting the power switch off and on, but without the wear and tear on both the electronics and the switch.

For those of you who like a numeric keypad, a special connector has been provided on the motherboard to make installation a snap.

A builtin self-test function is activated by pressing Reset while holding down the Solid Apple and Control keys. If the memory and various circuits pass a 20-second test, the message "KERNEL OK" appears on the screen. The Open and Solid Apple function keys are also user programmable and are internally connected to the game paddle switch inputs, PB0 AND PB1.

One of the most popular features of the Apple has been its ability to accept a host of peripheral devices via eight internal expansion slots. Along with the more common devices such as printer interfaces, disk controllers, and extra memory boards, you will find Apples with music synthesizers, analog/digital and digital/analog converters, CP/M boards, 80-column boards, modems . . . the list goes on.

The IIe, by the grace of Apple, has retained this feature and added some extras. Slot 0, which was generally used for a 16K memory expansion board, has been eliminated, and the extra memory is now built in. Instead, the slots are numbered 1 through 7 and generally accept all the plug-ins that work in the Apple II, except for those which require direct connection to the motherboard or to an IC socket.

The back panel has also undergone a redesign. In place of the slots that were on the Apple II, the IIe has a metal back panel designed to accept 9-pin, 19-pin, and 25-pin D type connectors. Use of a metal panel cuts down on interference. There are 12 pre-cut openings complete with plastic caps to cover the unused ones. New peripheral devices designed for the IIe will have connectors to fit these slots, eliminating the need to remove the lid and sometimes a plug-in card to disconnect a cable.

A new nine-pin game paddle connector has been installed next to the video and cassette recorder jacks. You can still use a cassette tape recorder; although very little pre-recorded software exists, schools can cut down on their initial investment by not having to purchase disk drives for each unit. The old style game paddle connector is still available inside the case to accommodate existing devices, a thoughtful consideration.

In spite of the constant criticism about Apple's 40-column limitation, the Apple IIe is still a 40-column machine. Why? In the beginning, the Apple

was designed to be connected by an inexpensive RF modulator to any black-and-white or color television set. Monitors were very expensive then, and television sets as a rule do not have sufficient bandwidth to display 80 columns clearly. Even today, most programs that use Apple's color graphics work very nicely on any color TV. This plus the fact that Apple wanted to keep the IIe compatible with the existing software base more or less forced the company to stick with the narrow line.

To accommodate those who need a full 80-column display, Apple offers two optional 80-column cards: a low-cost standard 80-column Text Card and an Extended 80-column Text Card that also adds 64K of memory to give you a total capacity of 128K. This does not, however, mean that the IIe is a true 128K machine; rather, the two 64K banks are switched in and out under program control. Many programs now available take advantage of this extra memory automatically. These display cards plug into a special 60-pin auxiliary socket, but function in a manner similar to when an 80-column board is plugged into slot #3.

Like the Apple II, the IIe comes with two standard graphics modes. A low-resolution mode displays 16 colors in either a 40 horizontal by 48 vertical resolution or a 40-by-40 resolution with four lines of text at the bottom of the screen.

The high-resolution mode displayed six basic colors—black, white, violet, green, blue, and orange—with a resolution of 280 horizontal by 192 vertical (or 280h x 160v with four lines of text). If you have the Extended 80-column Card, you can also display double-density graphics in both low and high resolution modes; standard 80-column cards provide low-res only.

Don't be misled by the apparent limitation to only four actual hi-res colors. Many programs use various techniques of shading and mixing colors to achieve hundreds of color variations.

Unlike most other new-to-the-market computers, the IIe already has an established software base of thousands of programs. In fact, because of the great number of Apple II/II+ systems that already exist, many software manufacturers are configuring their programs to adjust themselves automatically to the model of the computer in use.

As of this review, all Apple IIe systems sold with at least one disk drive are being shipped with the new ProDOS operating system as well as the older DOS 3.3 system. Once existing supplies are exhausted, only ProDOS will be supplied. ProDOS stands for Professional Disk Operating System and differs from DOS 3.3 in that it supports hard disk drives such as the Apple Profile, as well as floppy

disks. It is very similar in design and operation to the Apple III's SOS system.

Times have changed, and so has the style of manuals supplied with Apple's computers. At one time an Apple II came with a programmer's reference manual, a hardware reference manual complete with schematics, and a DOS manual. What was lacking for the nontechnical computer user was a simple set-it-up and run user's guide that didn't require a degree in computer science to understand. Now the IIe comes with only one simple book: The Apple IIs Owner's Manual.

Clearly written and lavishly illustrated with color photos, it tells how to do everything from unpacking and setting up to explaining all the various parts of the computer in terms the average housewife can understand. If your system includes a disk drive, you will of course have manuals on both the hardware and operating system.

A disk called "Apple Presents Apple IIe" is also provided to help break the ice for those first-time computer users. An interesting and informative tutorial, it utilizes excellent graphics along with some humorous text to take you step by step through the IIe's keyboard and features.

For those who must get into the guts of things, the Apple IIe Reference Manual is available at additional cost. It includes detailed descriptions of the hardware, its operation, special features, timing diagrams, pin-outs, and a complete set of schematics. Other optional manuals include a two-volume Applesoft reference manual, Applesoft tutorial, BASIC programming manual, DOS programmer's manual, and a DOS user's manual with tutorial. The Apple IIs in the past have always been well-documented, and the IIe is certainly no exception.

In all, the IIe remains what the Apple II has always been: a nearly ideal computer for beginners. With plenty of power on its own, it can also grow, through the use of add-on cards, into a vastly more potent business or scientific computer. This almost completely eliminates the risk of discovering, after a few weeks of learning, that your computer can never do what you really need to. No other machine equally well suited to beginners can make the same claim; not even Apple's own Macintosh and IIc.

Apple Computer, With 64K RAM and one disk drive \$995; With two disk drives, monitor, and Extended 80-column card \$1,795; With single floppy disk drive, 5 MB hard disk, monitor, and Extended 80-column card \$2,999; 80-column card \$125; Extended 80-column card \$295; Duo-Disk drives \$795; Tilt-screen monitor \$229

ATARI XL SERIES

Atari has had some rough times recently. There have been well publicized layoffs, outright firings, cancellations of announced new products, and widespread budget cuts. After Texas Instruments got out of the home computer business, many said that Atari was next. Instead, as this book goes to press, former Commodore head Jack Tramiel has taken it over, fired all but a few hundred employees and announced that a whole new line of computers is under development.

The worst of the many blows leading up to this dramatic change was probably the foulup at the 1983 summer Consumer Electronics Show. Atari announced five products there that excited the entire Atari world: the 600XL, 800XL, the 1400XL, the 1450XLD, and the CP/M module. And rumours were flying about the 1600XL, said to be compatible with the IBM PC.

Then things began to slip. First the 1450 and 1400 were "indefinitely delayed." The 600 and 800 machines shipped late. The CP/M module became "unavailable," even though many distributors showed it in their catalogs. Finally the news came: the 1600XL had been dropped, so had the 1400XL; the CP/M module didn't exist, and the 1450XLD was "back for a redesign." Atari's credibility dropped considerably.

Yet two of the new computers did eventually make it to the market and they are giving what remains of the company a needed lift. The 600XL and 800XL computers, now available, are replacements for the very popular and powerful Atari 400 and 800 computers. Like the older models, the XL computers are built around the 6502 microprocessor. Both come with typewriter-style keyboards. The two machines are nearly identical except for memory; the 600XL sports 16K of RAM, the 800XL 64K. They both have a sleek, well-designed appearance. The 600XL retails for \$199, the 800XL for \$299. At these prices, and with their features, they are making a good bid to restore Atari's position in the low-priced computer market.

Probably the Atari's most remarkable feature is a powerful graphics processor in two chips, called ANTIC and GTIA. Only Atari has these chips, and they give the XLs the clearest and highest-resolution TV image in the industry. The Atari was literally designed around the task of driving a TV; even the internal processor clock, 1.79 Mhz, is derived from a TV color clock. On machines that are not so designed, you will see fuzziness and color bleeding; the Apple and Commodore are two good examples. The risk of eyestrain is a significant factor in buying a computer, all else being roughly equal, and the

clearer the display, the better. You'll find a video monitor connector on the back of the 800XL, but not the 600XL. This gives NTSC composite video for a color monitor if you decide to use one.

On the same connector is audio output, which can be connected directly to a AUX IN or TAPE INPUT of a stereo amplifier for best reproduction of the Atari's sounds. A TV speaker cannot do justice to the sounds the Atari can produce, but a good stereo system can. The much vaunted sound synthesizer chip in the Commodore 64 is slightly superior to Atari's POKEY, but when they are both played through the same TV speaker the difference is hard to detect.

The 600XL and 800XL also have an external power supply; the transformer and capacitors that change the 110-volt line voltage to the internal 5 volts are outside the machine. This is an important move because it means that there is a great deal less heat dissipated inside the XL's case. Heat causes enormous problems for computer circuit boards, and the less generated, the better.

The keyboard used on both machines is a big improvement over the old Ataris. The 400 had a flat membrane keyboard that was particularly difficult to type on. (It did have a major advantage, however; it was completely child-proof and spill-proof.) The Atari 600XL has a fine, full-stroke keyboard that touch typists will be very happy with. The 800XL has a keyboard similar to that of the 800, with a few keys moved around to accommodate typists; in particular, the annoying "mode inverse" key has been moved away from a location in which it was often struck accidentally. The keyboard has a responsive, springy feel to it, and can be typed on for hours without tiring out the user.

The "RESET" and "OPTION/SELECT/START" keys are still on the keyboard, moved to stylish metal buttons on the right. A new key, called "HELP," is also available. While little software uses the HELP key because it is so new, more and more is sure to become available soon.

The OPTION key is used to decide whether or not your XL machine will come up with BASIC. The cost of producing chips has dropped so much that Atari has included BASIC inside the machine. (The older 400 and 800 machines had BASIC on an external cartridge.) The new version of BASIC has fixes for several of the problems with the old version, including the dreaded "lockup" problem, where the machine would crash while editing a BASIC program.

There's another exciting new feature on the 600XL and 800XL: a bus connector. On the older machines, Atari supported only one means of ex-

panding the machine, the serial connector. Disk drives, printers, and modems all connected to this one port. Unfortunately, such popular items as 80-column boards don't work well through this port, and the disk drives connected through it run very slowly. Several third-party manufacturers offered boards that plugged into the Atari 800's memory board slots to run fast disk drives or 80-column video.

However, this new bus connector makes adding such devices easy. The entire data and address bus is now available external to the computer. Already a number of companies have announced work on items to plug into this bus, and 80-column boards and fast disk drives will shortly become a reality.

Because the Atari can transfer only 1,920 characters per second up the serial bus, but can transfer 500,000 or so per second through the new bus connector, this offers a great opportunity to speed up the data transfers to outside devices. This is one reason the bus connector is so important, and why it has generated such excitement at Atari.

If you buy the 600XL, and decide to upgrade it to 64K, an add-on module is available that plugs into the bus expansion connector. However, if you are planning to do much with your computer, it is best to begin with 64K; 16K is not much space in which to do anything. Even many games on the market require at least 48K. At this point the 800XL is a significantly better choice than the 600XL for most any purpose; even if you buy the 600XL for a specific task, sooner or later you will want to do something else with it.

There's a bit of marketing in rating the 800XL as a 64K machine, incidentally—the need to compete with the Commodore 64, which also claims 64K. It is true that both machines have 64K of memory on board; however, in most cases only part of the total memory is available. In the Atari, the onboard operating system overlays the upper 16K and for nearly all applications must be left in that area. Hence, only 48K is available for use. The same thing applies to the Commodore.

Atari has always had the reputation of being a games machine, and it is generally true that the best, most colorful, and highest-speed games are found on the Atari. It has the widest collection of game software available for any machine, including the Apple. Given Apple's lead time, this is amazing. The reason is that programmers love to work with the Atari. Remember that programmers only have a TV image to communicate game designs to you; the more powerful the tools to generate the image, the better jobs they can do. Many programmers are creative, and many have chosen the most

powerful tool available—the Atari machines and their graphics chips.

POKEY, the sound generator chip, is another strong attraction for creative programmers. This chip provides the Atari with four channel sound and even the ability to output digitized sounds; this means that the Atari can talk. Such games as *Berzerk*, *Tumble Bugs*, and *PokerSAM* use POKEY to speak, pretty clearly, through the TV.

Some of the best synthesized music, bar none, comes from the Atari. The best is probably the theme to the game *The Tail of Beta Lyrae*, from Paradise Programming in Hawaii. A close second is Ed Rotberg's synthesizer package. If you get a chance to look at either of these, you'll be convinced of the Atari's power.

Despite all this, the emphasis on games for the Atari is slightly misplaced. There is a wide choice of software available for the Atari machines—perhaps not as many titles as can be found for the Apple, but a very good range. Some of it is quite sophisticated.

Programmers, for example, will find much to interest them. There are a variety of helpful add-ons for Atari BASIC, and a much expanded version called *BASIC A+*, from OSS in Sunnyvale. *BASIC A+* now comes in a reworked version also known as *BASIC/XL*.

Perhaps you'd like more structured programming power? The Atari Program Exchange used to market a fairly good Pascal. Atari has recently discontinued APX, but some computer stores may well still have some of their products in stock. You will need two disk drives to use the Pascal.

Or perhaps you'd like to go for speedy, structured code. There's several FORTHS, among them, *Pink Noise FORTH*, *Coin-Op FORTH*, *QS FORTH*, and *ValFORTH*. Probably the best is *ValFORTH*; the documentation is complete and fairly awesome.

Maybe you'd like to try assembly language? You'll find a wide selection of assemblers, from *MAC/65* to Atari's popular *AMAC/MEDIT*, *DATASM/65*, *Synassembler*, even a cartridge from Atari. *MAC/65* has a particularly good reputation.

Finally, there's an exciting, powerful new language from OSS called *ACTION!*. *ACTION!* is a mix of Pascal and C and is designed specifically for the Atari; it is incredibly fast (right up there with machine code) but with the advantages of a high level language. It is probably destined to be the language of choice for Atari program writers.

Atari has also rewritten the operating system to allow several important new features, such as enabling external devices (printers, modems) to upload software to the Atari to drive them. There

are also several new graphics modes, including the much-asked-for "Graphics Seven Plus," a high-resolution, four-color mode.

This new operating system caused a small problem; a great deal of third-party software for the Atari did not follow Atari's rules for making operating system calls, and does not work with the new OS. (Properly written software, however, has no such problems.) Atari, however, in a spirit of co-operation, has made available a version of the old 400/800 operating system, on disk, which can be loaded into the 600XL and 800XL to enable them to run these programs.

Atari has also released some interesting software for their machines. There's the fabulous *AtariWriter*, a great word processor at low cost, enabling a user to put together an inexpensive Atari word processing system that will outperform the Coleco Adam for nearly the same price. *AtariWriter* is very easy to use and may be the best word processor available for a 40-column screen. Atari has also released a very inexpensive 80-column letter quality printer, the 1027. The 1027 is moderately priced at \$349, yet prints at a reasonable 20 characters per second. *Consumer Reports* has rated the *AtariWriter* package, 600XL, and 1027 printer as the best value in inexpensive word processors, ahead of even the much publicized Coleco Adam.

And there's the new *Syn-Apps* package, from Synapse Software, one of the largest independent Atari software houses. With a spreadsheet program, word processor, and database program, all able to communicate with each other, it closely resembles the IBM's *Lotus 1-2-3*. Atari's business capabilities used to be a rather weak point; *Syn-Apps* goes a long way toward correcting this deficiency. Synapse has always had a fine reputation for quality work, and many are looking forward to these products. Synapse also produces many games for the Atari, and their games are among the most imaginative and best implemented.

Though the 1400XL announced at the CES has been dropped, there is still one more Atari to consider. The Atari 1450XLD, announced at CES, has been sent back for redesign. As described last year, the 1450 offered the speech synthesizer and the modem of the 1400, and added a high-speed double-density, double-sided disk drive. This was a step in the right direction for Atari, whose 810 disk drive is markedly outdated and whose 1050 disk drive has a bizarre "dual density" format that stores only 120K per disk, where most aftermarket dual-density disks for the Atari store 170K.

The 1450, however, had two major problems. The first is the IBM PC jr; the second is the Apple IIe.

Both can be purchased for under \$1000, and both outperform the original 1450XLD. Indeed, Atari had designed an MS-DOS compatible machine, the 1600XL, in house, and was set to announce it at CES; however, Atari had no resources to support this machine and it was cancelled.

The 1450 is just being finalized as of this writing. It will represent a path for upwards migration by Atari users, and is an important machine in that regard. A rare pre-release demonstration of the 1450 showed it to be a powerful machine indeed; for instance, how many home computers can answer your phone when it rings and deliver a synthesized message to the caller? The speech synthesis is superb, too. Disk storage and speed have also been vastly improved.

The Atari CP/M module, announced at CES before the new Atari president ordered employees to stop talking about products they could not yet deliver, has been dropped. According to an internal memo, Atari felt that it could not compete with a third-party unit called the ATR-8000, which is also available as a powerful CP/M computer. At press time there are rumors that Atari may even buy out the ATR and make it their own product.

One final advantage of the Atari machines is the expansion box that plugs into the back of the XL machines. The box, in turn, will support a variety of plug-in cards. While Atari is most reluctant to discuss specifics, they do plan to release many of these cards themselves. A few that are definitely in the works are a disk emulator for high-speed data storage, an 80-column card for serious word processing or spreadsheet work, and an 80186 card to run MS-DOS and IBM software. The 80186 is a high-speed, very powerful version of the 8088 used in the IBM; the 80186 is being used in the Tandy Model 2000. If and when this card becomes available, the Atari will gain the ability to run a wide range of software, including a great deal of IBM material. It will add enormously to the Atari line's appeal.

Overall, the Atari machines are targeted at the home market. In many ways, they are better designed and a better value than the competing Coleco and Commodore machines. This reflects Atari's long experience in the market and the wide software available for these machines. To some extent, Atari has helped its competition to do so well; mismanagement and support problems have hurt badly. But with new policies in effect at Atari and a new determination to win back their market, it is easy to recommend the Atari machines to anyone.

Atari, 600XL \$199; 800XL \$299; 1027 printer \$349

ATR-8000

You have probably heard of the ATR-8000; it is a machine with a limited advertising base. Or you may have heard that it is for Atari users only. This is not so; this is one of the better CP/M machines available, with some of the best hardware and software ever produced for a Z-80 based computer.

The confusion comes from the ways the ATR-8000 is offered and advertised. There are three basic models. The first is an Atari expansion box only; it is used to provide basic I/O functions to the Atari at low cost. The second machine is an Atari expansion box and a powerful CP/M computer. The third machine adds the ability to run MS-DOS—IBM PC—and CP/M 86 programs.

The ATR-8000 provides a fascinating number of capabilities to the Atari owner in its "expansion box" mode. In the CP/M or MS-DOS modes, however, the Atari is just a terminal to the ATR-8000, which becomes the primary processor. Any terminal capable of running at 9600 baud can be plugged into the ATR; you don't need an Atari to use the ATR-8000 at all.

To begin, let's cover the first mode, with the ATR as an Atari expansion box. The Atari communicates to the outside world via the serial I/O bus, the 15-pin connector and thick cable that goes to 810 disk drives, the 850 interface, the 1027 printer, and whatnot. Now Atari sells a number of peripherals that you can add to their computer, and they all have one common attribute: they must be "smart."

Atari computers cannot spare any of their brainpower to run attachments, and the serial bus protocol makes it impossible for them to try. Each independent device must have an internal processor to run it. Instead of hooking a "dumb" peripheral, such as a standard disk drive, onto the Atari, we must hook on a "smart" drive, like the Atari 810. This costs much more. The 810 retails for \$499; an equivalent Tandon TM-100-1 costs \$179. That's a \$320 difference. And if you want to add a second drive, Atari units will cost \$1,000; the Tandons would be \$360.

Or take the 850 Interface. This is the only way to connect an Atari to a Centronics parallel printer, the most common printer interface in the industry, or to an RS-232 device, such as a printer or modem. The 850 is expensive and difficult to obtain; Atari is apparently trying to force users into using Atari peripherals only by restricting devices that allow the Atari to use outside vendor's hardware. The 850, if you can find one, will run you about \$220.

So you'll understand excitement about a device that provides, for \$350: an interface to any kind of

disk drive you like, including 3-inch, 5-inch, or 8-inch, single- or double-sided, single- or double-density, 35-, 40-, or 80-track; a parallel printer interface; a serial (RS-232) interface; 12K of printer "spooling" (in this function, the Atari prints into the ATR-8000's memory, and the ATR in turn drives the printer while the Atari can do other things. You don't have to wait for the printer anymore. And, you can expand your system to CP/M or MS-DOS).

This is the key to the ATR-8000. They took most Atari peripherals, each requiring a separate smart processor, and combined them into one box, requiring only one Z-80. The ATR-8000 provides about all the expansion an Atari owner could want. No wonder the machines are back-ordered a month!

Interfacing the machine is a snap. Any hacker has heard, and lived through, horror stories about connecting printers and disk drives, with tales of swapping leads, oscilloscopes, and the like needed to get things working. It took ten minutes putting clamp-on connectors from Radio Shack onto cables to get an ATR-8000 hooked up. The manual is most complete and specific about how to hook up the machine, but you are not likely to need it.

The ATR's most awesome feature, though, is its disk hardware and software. Most other computers do not even try to mix 8-inch and 5-inch drives on the same cable, for instance. Nor do they automatically sense the drive size from the index pulse timing, automatically sense the disk's density, the sector size; neither do they re-configure their own internal software as necessary to use the disk. Everything is handled for you if you use a reasonably standard drive; if you pick a strange drive, change just two parameters in an easy-to-use, well-done menu, and you're all set. This is disk interfacing at its very best.

For instance, on the system reviewed, there were two 8-inch Shugart drives, one 5-inch, double-sided, 40-track drive, and one 5-inch, 80-track, double-sided drive. The ATR was able to select flawlessly between them, transfer data, format, and in general use the disks without any problem.

Why is this so amazing? Because no one else in the industry seems able to do it. For instance, on a typical CP/M system, only one 5-inch disk format is acceptable. If it can accept 8-inch drives at all, it will do so only if you change jumpers and solder capacitors into the hardware. The IBM won't even look at an 8-inch disk without a special board from an outside vendor. And along comes the upstart ATR-8000, which uses anything, without any problems, any software modifications, or hardware changes!

By the way, all of this disk information applies to CP/M, also; not only the Atari can use all these different drives. More on this in a bit.

The ATR-8000 also comes with MYDOS, a rework of Atari DOS, which allows you great power in disk-drive use. While Atari DOS stuck you with 88K per disk and no way to expand, due to its internal structure, MYDOS lets you use up to a whopping 1.4 megabytes per disk, all in Atari-compatible format. This gives the Atari decent data storage capacity, all without sacrificing compatibility. This saves money directly in diskette costs; the ATR can write double sided, double-density disks, putting 360K per diskette. There's a 4-1 advantage to begin with.

If you've added up costs for an ATR vs. Atari-based system, then you're already sold. If not, consider it: An ATR-based system with two disk drives, RS-232 port, and print spooler will cost \$350 for the ATR-8000 and \$300 each for two Tandon TM 100-2 disks, with cases, for a total of \$950. An Atari system with the 850 Interface for \$220, two 810 drives for \$1,000, and a 16K printer spooler for \$200 totals \$1,420. And the Atari system offers far less disk storage—160K vs. 720K—and no way to expand into CP/M.

CP/M is the second upgrade to the ATR. Getting into CP/M is easy; one loads a terminal program into the Atari, making it appear to be an ADM-3A terminal, and the ATR boots into CP/M. To begin with, everything I've said about easy disk interfacing applies to CP/M. This is the only CP/M I have seen that boots directly from either 5-inch or 8-inch disks and the only CP/M that automatically configures itself for the drives you have on-line.

This CP/M is fast. If you so choose, the disks will have 1,024 byte sectors, which means that out of eight times CP/M instructs the ATR-8000 to read a disk sector and transfer 128 bytes of data, only once will the ATR have to go to the disk. The other times, the information will come straight out of memory at very high speed. The system boots up, as an example, in about two seconds flat.

The machine was tested with all sorts of different CP/M software, and it seems to run everything without problems. This includes such popular programs as *Wordstar* and *Spellstar*, *MBASIC*, *CBASIC*, *dBASE II*, the Infocom games, and so on. It is a standard 64K CP/M system and thus has a great quantity of software available.

For the Atari owner, this means getting into CP/M and in particular business software. The Atari does not have much business software available directly, due to an unfortunate corporate delusion that business software is not for home computers. However, the CP/M business software library is

huge; it is the standard by which even IBM's software collection is judged. If you own an ATR-8000, you can access all this software with an absolute minimum of hassles getting the system going.

Finally, another added bonus: The ATR can read many foreign disks directly. *Diskdef*, supplied with the ATR, gives you a menu of about 30 different vendors and disk formats, Osborne, Kaypro, and IBM among them. Just select the format and drive name, and that drive will begin to read and write disks in that format. More formats are being added to *Diskdef* periodically; a revision to use more double-sided formats is on the way.

The third step up is the Co-Power board. This is an 8088-based processor with 256K of RAM, and it is the final expansion for the ATR-8000. You can use it in two ways: You can specify the RAM as a disk drive, in which case you have a disk drive of ultra-high speed and 250K of storage. This is great for word processing, spreadsheets, spelling checkers, disk copying, and the like. Or you can run MS-DOS—IBM software—on the 8088.

In the first case, the Z80 remains the main processor, and the 8088 worries about disk requests to memory; the Co-Power board makes "disk" accesses to its memory incredibly fast. In the second case, the 8088 becomes the main processor, and the Z80 handles I/O requests, which again makes for a fast system. The Co-Power system will handle some IBM software, but not all; anything that depends on the IBM hardware won't function. Fortunately, the number of IBM compatibles on the market is forcing software developers to stay within the MS-DOS guidelines for software, which the Co-Power board follows.

Incidentally, the Co-Power board uses the CP/M-80 system for input and output, and is thus quite generic. Already 8088 Co-Powers are in use in Kaypro and Osborne systems, and more are on the way. In an increasingly IBM-dominated software industry the ability to run IBM software is crucial; the Co-Power board represents a reasonable way for a Z80-based system to become IBM compatible.

Strange corporate policies have left Atari users increasingly isolated from the rest of the micro-computing world. The ATR bridges that gap with disk and CP/M compatibility for the Atari owner. Furthermore, it also bridges the gap to IBM compatibility, providing future compatibility that Atari corporate never will.

All in all, the ATR-8000 is highly impressive. A machine like this comes along only every so often, and it sets the standards by which other systems are judged. The ATR-8000 is a very cost-effective Atari expansion, a problem-free CP/M system of

very high power, and an IBM-compatible, all in one box. It's an incredible buy.

ATR-8000 \$450; with CP/M \$1,099.95

COLECO ADAM

There's a real difference between designing a machine and advertising it at low cost and actually producing a quality item for that low price. Coleco has found this sad fact out with its new machine, the Adam. The Adam has received a great deal of press attention with its announced \$600 pricetag for a full system with computer, tape drive memory, and letter quality printer. Many felt that the Adam would finish the Atari off in the home market and give Commodore serious competition.

It all seemed too good to be true, and since then many disquieting things have happened. First, the price jumped to \$700. Then rumours of quality control problems and poor reliability surfaced. And Coleco was very late in shipping systems it had promised.

The Adam today is very much a compromised machine. It has lost its aura of low cost, and the media attention it has been receiving is most cautious.

The Coleco uses a Z-80, operating at the usual 4 MHz. It includes 80K of memory, means there is some sort of memory selection trickery going on; the Z-80 can only talk to 64K directly. The Coleco uses the same setup as the Colecovision game machine, so you can save some money on the Adam by plugging an adapter into your game machine and using that machine's processor, a nice move on Coleco's part.

Coleco also makes adapters for the Atari 2600 VCS game machine, so you can play all the 2600 cartridges, and there's even a steering wheel/foot pedal combo for the "Turbo" game in the works. Coleco is aiming the Adam at a home market of game players and word-processor users, with a light sprinkling of those who wish to learn programming. While the word processor is in ROM and always available, the BASIC—by MicroSoft, to Coleco's credit—must be loaded off tape, which takes around two minutes.

The idea of having a home computer that grew from a game machine is a nice one indeed. It helps end the era of disposable computers, such as the Atari 2600, that have powerful processors but that cannot be expanded. Coleco apparently thought far enough ahead to make their Colecovision machine truly expandable, a commendable corporate effort. Using the game machine to base an Adam

system will save you money; the regular Adam costs \$700, and a game machine based Adam costs \$400.

The display used is a regular TV. Coleco puts 36 columns of readable quality on the screen. There are 24 lines, which is pretty standard. However, this means that during word processing the text you see on the TV is not as it will be printed. The standard letter has 72 columns across, not 36, so a bit of imagination is required to visualize what the final result will look like on the printer. On this system, it is best to use your imagination; printing out the letter can take two minutes per page.

The keyboard has a nice feel, and touch typists should have no problems with it. The Arrow key group is a nice touch, with all four Arrow keys grouped around a common "home." The word processor comes in ROM and is available immediately when the machine is turned on. Coleco has certainly tried to make its word processor easy to use. Most commands can be activated by pressing one key. The usual insert, cursor movement, and block-movement commands are readily available. (Incidentally, the Arrow key group is a nice touch, with all four Arrow keys grouped around a common "home.")

The word processor is also fast; not even a fast typist is likely to overrun the keyboard inputs. The "Undo" key, which literally undoes what you last did, is a very pleasant feature for those of us who make mistakes while entering commands; for instance, it will "undelete" text that has been accidentally destroyed. Ten keys of the 75 on the keyboard are dedicated to the word processor, which ought to tell you the priority that Coleco gives word processing. Clearly a lot of effort went into this word processor; it is most adequate for home and limited business use.

Another nice thing about the keyboard is that it can be detached from the unit. This allows you to position the keyboard wherever it is most comfortable for you. This is very important for extended word processing; IBM did the same thing with both the PC and the PCjr for the same reason.

The printer is, well, low cost. It is very noisy and quite irritating. While the Okidata 84, for example, is much louder, at least it gives off a steady loud noise; the Adam printer's is a ratchety, jarring, and rather hard to stand. No one would be likely to use this printer in a dormitory, say, with other people around. At 10 characters per second, the printer is also quite slow. You can spend two minutes printing a single page, which is a bit ridiculous. (It is common for touch typists to type more than ten characters per second.) And because what you see

on the TV is not what you get on the printer, you often need several passes of editing and printing a document, all at the same slow speed.

Coleco stayed away from costly disk drives and went with a cassette-based "digital data pack." (It is truly amazing what a marketing department can name a tape cassette!) There have been many reports of problems with this pack, mostly accidental erasures, which Coleco is said to be looking into. The pack holds 256K of data; this is between what quality single- and double-sided disk drives would store, so there is no problem with the amount of storage. However, a new tape costs \$10, compared to a diskette cost of around \$2. Add to this the slow "seek" time it takes for a tape to get to any particular item of data, and the slower access time once data is found, and this idea is not clearly a winner.

Coleco has further expansions announced for their machine. (Whether or not they become available is another matter.) There's a modem, a program to allow video "painting," an RS-232 interface to drive non-Coleco printers, a disk drive with 360K of storage, a paper tractor feed, and an 80-column display for a monitor. All of these options together could help make for a more powerful computer. An 80-column display can let you see what your printed text will look like before printing, which can save you one pass during editing. And the disk drive will make a considerable difference in this machine, not only in accessing data faster, but in the hope of transferring CP/M programs from other machines.

Further, recently announced hardware expansions include a second tape drive, a 1200 baud modem, and a 64K memory expander. While no details are given about the memory expansion, there's a great deal to be considered here. The system will total 144K with the memory expander, and a Z80 can look at only 64K at any one time. So the memory must be swapped in and out and used only 64K at a time. This makes for a very fast computer, if you have software that takes advantage of this capability.

For instance, if a word processing program has certain little-used sections, they can be left out of the main program and put in auxiliary memory. This leaves main memory for the truly time-critical functions, like handling key inputs. Then, when the little-used function is accessed, it comes in out of auxiliary memory. This is not as fast as main memory, but it is much faster than a disk drive or tape cassette.

One application for this much memory is a spelling checker. Spelling checkers have huge dictionaries for use in checking the spelling of words in

your documents. These dictionaries get a bit unwieldy; 100K is a common size. If Coleco uses the spare 64K of memory correctly, then a spelling dictionary could be stored in that auxiliary RAM and thus be accessible at very high speed. This would make a spelling checker program, such as the popular CP/M *SpellStar*, run much more quickly.

"Bank selected" CP/M 3.0 from Digital Research is available for systems that have more memory than the processor can use all at once. While Coleco has not announced this particular breed of CP/M, it seems a natural for the Adam.

Software that is supposed to be coming in 1984 includes many CP/M packages, on the special tape format, the LOGO language, and the two most popular computer applications, a spreadsheet and database program. For a spreadsheet, *SuperCalc II*, an extremely popular spreadsheet, will be offered. The database program has not yet been announced.

Because of the strange media format, it would normally be some time before outside software producers include the Adam in their product line. However, Coleco is going out of its way to bring popular software titles to this machine quickly, in the tape format. This makes good business sense, as customers are beginning to discover that software availability is the key to owning a computer: Without software, a computer cannot do anything. The more software available, the more powerful a computer is; a computer without software is like a library without books.

Some titles announced for the Coleco are Broderbund's popular *Choplifter* and *AE*, Synapse's *Necromancer*, a new line featuring Dr. Seuss, another with the Smurfs, and others. The popular Infocom line—*Zork*, *Deadline*, and others—is soon to be available, as well as Spinnaker's well known children's educational software line, Sierra On-Line's *Adventures*, and other programs from Data-most and Epyx.

The overall impression that the Adam leaves is one of a machine that was hurried. The press releases came out, the Adam was hyped, and somewhere inside Coleco a harried engineer fought to get the thing finished in time for the Christmas rush. So some compromises were made.

The mark of a good company is whether or not it will support a flawed initial release. For instance, one of the reasons that the ATR-8000 stayed on the market, despite flaws in the early machines, was their willingness to work through the problems and support their dealers. To their credit, Coleco is making an effort to support this machine. While they can't admit the original release has problems,

they will change what obviously needs upgrading. This is a very good sign.

The new hardware and software releases scheduled for 1984 may soon correct the problems in the machine. If there's a 360K disk drive to supplement the tape transport, then the Adam may turn from a potentially great home machine with some kludgy features to a truly great home machine. It is quite possible that the next year will bring a greatly improved, truly powerful computer.

Coleco Industries, \$699.95.

COMMODORE 64

The Commodore 64 may already be the best-selling personal/home computer in history. The reason? More bang per buck. While not a full-fledged business machine, it gives surprising performance at a record-setting price.

In a way, the 64 could be considered the sequel to the VIC-20, Commodore's other popular computer, which the 64 resembles. In fact, it is widely known outside the United States as the VIC-64. But the resemblance stops with the computer's physical appearance. Where the VIC-20 came with only 5K of memory and was limited to no more than 32K, the 64 comes with 64K of RAM, standard. The VIC was Commodore's first machine capable of displaying color graphics. The 64 improves on them, offering higher resolution, more colors, and movable screen objects called "sprites." The 64's ability to generate sound far surpasses that of the VIC (and almost every other personal computer to date) and approaches the power of an electronic music synthesizer.

Like the Apple II and Atari computers, the 64's standard text screen display is organized as 25 lines of 40 characters. Each character can be one of 16 different colors; the background and border can be set, as well, to any two colors. The text display is one of the 64's primary limitations, particularly for business use. Though word processing programs are available for the machine, including a few very good ones, the 40-character lines do not display enough text to make for convenient editing, particularly with a long document.

In addition to the standard alphabetic and numeric characters, the 64 uses a set of graphic symbols inherited from the original Commodore PET. These can also be entered from the keyboard.

High-resolution video graphics are displayed in two different modes, either 320 by 200 pixels (picture elements, or dots on the screen) or 160 by 200. The difference between the modes is the number of colors that can be used simultaneously. Because

of an interesting way of storing color information, up to 16 colors can share the video screen. Though there are limitations to this scheme, some interesting and extremely attractive screen designs are possible.

Sprites add a distinctive look to the 64's video display. These are easily defined and displayed, even from BASIC. A sprite can be up to 24 by 21 pixels in size, and can be expanded horizontally, vertically, or in both directions. Depending on programming, each sprite can be comprised of up to four colors. (Some clever programmers have found ways to overlap several sprites so a single picture can use all 16 colors.) It is relatively easy to move sprites and to detect when one collides with another or with the background.

Inside the Commodore 64 is a complex (and complicated) sound generator chip known as the SID, for Sound Interface Device. The SID, a three-voice generator, contains most of the circuitry of a music synthesizer. The waveform of each voice can be selected from a sawtooth or triangular wave, pulse width wave (for square waves, etc.), or noise. The sounds can then be shaped by three individual envelope generators, which control attack, decay, sustain, and release values. Finally, a set of filters is used to color the sound further. There is also a ring modulator inside the SID that can yield some astounding electronic sound effects.

The value of the SID is evident, not only for creating arcade-style games, but for music as well. The SID chip has even been taught to speak intelligibly using only software. This is an extremely powerful addition to the system.

A unique serial I/O bus forms the basis for the 64's communication with its peripherals, disk drives, and printers. Unfortunately, the system is slow and tends to restrict use to the company's own products. Other printers can be connected by means of any of several interfaces that are sold, and third-party disk drives have begun to appear as well, although using these could make your system incompatible with certain commercial software. This serial I/O line is usually called the VIC bus, since it first appeared on the VIC-20. It conveys data at a relatively slow rate, about 350 characters per second. This means the computer is not good at swapping large amounts of information to and from the disk quickly.

The serial bus communicates with "smart" peripherals, each of which are assigned a "logical address" in order to share the same data lines. The same data is present at both a printer and disk drive, for instance, but only the appropriate device will pay attention to the information and act upon

it. Traditionally, the first disk drive in a Commodore system is numbered device #8; printers are device #4. When one of those numbers is used with a command from BASIC, the correct device will store the information or print it on paper.

On the other hand, there are plenty of other useful data connections. Two control ports can accommodate switch-type (Atari-compatible) joysticks, four game paddles, or any other potentiometer controls (like analog joysticks or the Koala pad), a light pen, or a trackball. An 8-bit parallel port on the back of the machine is nicknamed the "user port" and is a terrific connecting spot for hobbyists' and experimenters' projects. Data can be sent to and from this port, which is programmable from BASIC. It is a latching port, which means that the bits sent to it will stay set until cleared.

Several lines on the user port are also assigned to the computer's RS-232 serial port. Although the RS-232 port can handle most serial peripherals, like printers or modems, it is not true RS-232 in that the voltages used differ from that specification. (In engineering parlance, it is "TTL level" serial port.) This doesn't mean that it is useless, just that you must take extra care in connecting serial peripherals and that a special, but simple, interfacing cable is required.

Commodore has designated another slot as a port for game and other ROM program cartridges. While it functions chiefly for this purpose, it is otherwise extremely valuable, containing lines for addressing the computer's memory space and other vital connections. For example, Commodore has designed an inexpensive cartridge containing a Z-80 microprocessor that is attached here. This port holds the key to much further expansion and development of the 64 system.

Last, there is a connector for Commodore's 1530 data cassette recorder. Only a few users rely on tape cassette rather than disk storage (the company says that more than 80 percent buy disk drives), but this is also a handy place from which to draw power from the computer for interfaces, etc.

Commodore's 1541 single disk drive is almost a necessity. Each disk can contain up to 170K of information, and up to four disk drives can be used simultaneously. Unfortunately, it is the weak link in the 64 system. The 1541 is extremely slow—long programs can take a minute or two to load. This makes it difficult to use the machine for manipulating large quantities of data—say, with a file management program. It simply takes too long to swap data to and from the disk, so that chores that would be easy with a CP/M or MS-DOS business computer can drag on for hours.

The 1541 is also somewhat unreliable. Actually, if the disk drive works, it will work well, but the cheap components used to keep the price down cause frequent problems. The major fault is that the drive can become misaligned, rendering disks unreadable. This would not normally be a cause for alarm if there were any way to have it realigned quickly and easily. But, since Commodore machines are sold mainly in mass market retail outlets rather than computer stores, technical support and product repair stations are hard to find.

Naturally, our primary contact with any computer is through its keyboard. The 64 is fortunate enough to have a good keyboard—not a great one, but a good one. The full-stroke, full-sized keys have sculpted tops and a good feel. They are not, however, detented keys with a click or any other tactile response. Still, typing on the 64 is not a chore, and, despite a few misplaced keys, it is easy to become accustomed to the keyboard. This is important for serious tasks like word processing or spreadsheet calculations. A separate number pad is lacking, and Commodore should consider introducing one.

To a computer, architecture means the logical design of the machine—how it is structured and uses its memory. The Commodore 64 introduced a very clever design that has since been adopted by other personal computers, including the Atari machines and the Apple IIe. Since 8-bit microprocessors can address only a total of up to 64K of memory, the 64 plays some tricks to manipulate that capacity. For example, both ROM (in which the operating system and BASIC reside) and RAM share the 64K memory space, and some of the memory addresses.

The 6510 microprocessor, which runs the show inside the 64, is a variation on the familiar 6502 chip, the heart of the Apple and Atari machines. But the 6510 has some extra lines used to reconfigure the computer's memory. Portions of the ROM operating system can be switched out, effectively turning the machine into an all-RAM computer so that other programming languages can be loaded in place of BASIC. Programs on ROM cartridges can displace the operating system and BASIC ROMs, and can use as much of the 64K of RAM they need. Programs can also be written to switch between reading the contents of ROM and RAM. (*Simons' BASIC* works this way to maximize the use of memory.) Finally, as in the case of the Z-80 cartridge, an auxiliary microprocessor can read and write into RAM memory, using the internal 6510 only to communicate with it.

Relatively few programs were available for the Commodore 64 during the machine's first year,

perhaps because software firms feared that the 64 would soon be replaced, as the VIC-20 was before it. Today, a wide variety of programs is available for it, including a good selection of practical programs for business and home management and an enormous array of games.

Only one piece of software comes with the 64 itself—a version of BASIC. *Commodore's BASIC* (originally authored by Microsoft) is good, but inadequate. Specifically, the company chose to install a modified version of BASIC 2.0 in the 64, rather than the more recent 4.0, which included several fixes and disk operating commands. One of the technical problems with BASIC 2.0 has to do with the way the machine stores string, or non-numeric, information. If large numbers of strings are stored and changed frequently, the computer can appear to crash. It really doesn't, however, but begins performing a long and complex internal procedure nicknamed "garbage collection," during which it reorganizes memory. This is a major fault in the 64's design and one that could make it difficult or impossible to program certain applications in BASIC.

Other than that problem, the sins of *Commodore BASIC* are mainly sins of omission. BASIC does not provide any convenient way to use the spectacular graphics and sound features described above. These are accomplished using difficult PEEK and POKE procedures. And, Commodore BASIC lacks at least one vital BASIC command, "Priny Using," which correctly formats columns of numeric information on both the video screen or on paper. Many of the difficulties of Commodore BASIC are remedied by using a BASIC extension, such as the excellent *Simons' BASIC*, which adds 114 new commands.

Documentation supplied with the 64 is limited to a user's manual designed to get the beginner's machine up and running. However, a "Programmer's Reference Guide" is also available. Inexpensive and clearly written, it explains most of the details of the 64's operation. In addition, several dozen books have been published for 64 owners. One major chain of bookstores reports that for more than a year at least ten of the two dozen best-selling computer books each month have dealt with the Commodore 64.

This machine does have its limits. If you plan to use your computer most for word processing, you would probably be better off with a model that can put more text on the screen. If you need to store and manipulate large quantities of data, find one with faster disk access and, preferably, more disk storage space. And if all that interests you is play-

ing games or making pictures, Atari computers offer more sophisticated graphics than any machine in this price range. But if what you want is to learn about computers or programming, or to accomplish practical, but less demanding, chores, it will not be easy to match the 64's features at anything near its price.

With the onrush of newer computers built around faster and more powerful 16-bit and 32-bit microprocessors, the 64 may mark the end of the first era of personal computing, in which an 8-bit processor was standard and 64K a lot of memory. If so, that era has gone out at its peak. The Commodore 64 is a classic computer that has changed many ideas about performance and price.

Commodore Business Machines, Commodore 64 approximately \$210; 1541 disk drive approximately \$250

IBM PCjr

In 1982, IBM announced its first entry into the new microcomputer field, the IBM Personal Computer. Although the PC found itself in many private homes, it was not really a "home computer" like the Apple or the Commodore. Price was one significant factor that kept it out of that range, as was IBM's marketing position: They aimed the system at the business-oriented user and the larger, IBM mainframe shop.

Almost from that moment on, speculation ran high about a new machine that would topple the Apple out of first place in the hearts of home computer users. Dubbed the IBM Peanut by the press, rumors about the new machine abounded for more than a year, and reports of the Peanut's specifications and capabilities varied as much as the weather reports on the major television networks.

Finally, in late 1983, IBM unveiled the IBM PCjr, a real home computer from the most respected computer company in the land. But shipments of the system did not begin in quantity until early in 1984, giving Apple the 1983 Christmas market. Guesses about the cause of the delay ran the gamut. Seemingly the best pointed to a shortage of the new Intel 80186 microprocessor that many believed would be the brains of the Peanut. This explanation, too, was wrong, and IBM's marketing blunder has never been explained.

The PCjr is designed around an Intel 8088 microprocessor, one of the most popular and well-respected computer chips available today and the same one that powers the IBM PC. It comes with either 64K or 128K of RAM. The PCjr has two empty slots that will accept ROM cartridges, enabling the

user to run programs or computer languages without a disk drive. In addition, it comes with its basic input/output programs stored on 40K of ROM.

The PCjr offers much better sound and graphics than the PC. The PCjr has six graphics modes, double that of the PC and the PC XT, and it also can produce a far wider range of sounds than can the other two machines. This makes sense, as the PCjr looks much more like a game machine than a personal computer.

The keyboard has 62 keys, and has been described as a "chiclet" keyboard by the press and the microcomputer community, referring to the small, rectangular keys. By way of comparison, the standard IBM Personal Computer's keyboard has 83 keys the size and shape of standard typewriter keys. The keyboard uses an infrared beam to send its signals to the system unit, allowing the user to sit some distance from the computer itself. An optional keyboard cord is also available. In the opinion of many people, the keyboard is much too soft, and the keys are hard to use if you are used to a typewriter or computer terminal. In addition, it lacks function keys; commands that require a single keystroke on an IBM PC take two on the PCjr.

For another \$550 or so, IBM supplies an internal 320K disk drive for the PCjr. Anyone accustomed to the PC itself will find the PCjr's drive surprisingly slow. This is not the drive's fault, however, but rather that of the internal architecture of the PCjr. A more serious problem is that only one drive can be added. This makes it tedious at best to copy a disk, and it makes it difficult to manipulate large quantities of data. Some programs will not run at all without a second drive.

IBM also offers several options to enhance the PCjr. These include joysticks, an internal 300-baud modem, a thermal printer operating at 50 characters per second, and a monochrome or a color monitor to be used in place of a television set, providing much higher viewing quality.

In order to be used, a computer must have an operating system, and IBM has decided that the primary operating system will be an "upgraded" version of the PC DOS available for the IBM PC. The version number of the operating system is PC DOS 2.10, and like its predecessor, it was written by Microsoft Corp., of Bellvue, Washington, one of the leading microcomputer software houses in the country.

The only real difference between PC DOS 2.00 and 2.10 is in the ability to handle the PCjr. Thus, if you are using an IBM PC and do not intend to ever use the PCjr, you have no reason to switch to the new system. If you will be using just the PCjr, or

both the PCjr and the PC, you will need a copy of 2.10. IBM missed a good opportunity to upgrade DOS 2.00.

Because IBM chose to follow their PC standard in operating systems, much of the software that was written for the original PC can run on the PCjr. There are, however, some programs that just will not fit into the PCjr, either because they use more than 128K RAM or because they need more than one disk drive to do their job.

The PCjr comes with very good documentation, just as the PC did when it was introduced. As a matter of fact, microcomputer documentation was just awful before IBM came into the field, and they have done a lot for the industry by setting much better standards in this area. Besides the written documentation, the IBM PCjr comes with several disks full of sample programs and tutorials that teach the use of the machine and its various components.

The full set of machine documentation includes the DOS manual and, if you buy BASIC, the *IBM BASIC* manual. These were written for the larger PC and PC XT machines, and at times they may be overly sophisticated for most new PCjr users. It might be a good idea to pick up one of the many new books on the PCjr. Most of these were written with the first-time user in mind, and will step you through from very simple operations to the much more complex tasks of programming in BASIC or, even more mysterious, programming in assembler language.

Where, above all else, does IBM excel? In servicing what they sell, and the PCjr is no exception. Obviously, for a machine that costs less than \$1,500, IBM can't provide on-site, 24-hour service to all PCjr users, but it does the next best thing. In the onboard ROM that comes with the basic system, IBM has included a set of diagnostic programs that will check out all of the components of the computer for you and tell you what to do next. If the diagnostics indicate a problem, there are literally thousands of places to get it fixed. And the warranty will cover you for a full year; your machine will not cost you anything to maintain during that time. Do be sure, however, that you buy your machine at an authorized IBM dealer, as the warranty can be a problem to you if you don't.

How does the PCjr measure up against the competition? Not very well, many customers seem to think. Computer-market analysts almost universally give the little IBM credit for soaring sales of the Apple IIe. While there are many reasons for this, they amount to one thing: IBM seems to have decided to cripple the PCjr so as not to take sales

away from its PC and PC XT systems. In doing so, they produced a machine that, by itself, cannot justify its price.

The cheapest PCjr you can buy will cost you about \$700; it will not be a stand-alone system. You must add over \$100 worth of essential equipment to run the machine, and that doesn't include the television set. The computer comes with 64K of RAM, enough to do some of the basic things that you want to do with the computer, but hardly a lot of memory in these days of 512K machines.

If you want to buy the upgraded PCjr, you must plunk down almost \$1,300, plus over \$100 for the equipment it takes to tie the computer into your television set and to give it a language to speak—*IBM Cartridge BASIC*. This will give you a 128K system and a 320K disk drive as well. Now you have a machine that is cheaper than an IBM PC but still expensive next to the machines with which it was supposed to compete; it still falls well below the PC in power, but it will hold its own in the home computer field.

If a prospective purchaser wants a simple game machine, it can be had for many hundreds of dollars less than the IBM PCjr. If, instead, a full-fledged microcomputer is the goal, then there are many good ones on the market for not too many dollars over the cost of the PCjr. As far as many consumers are concerned, the PCjr just doesn't have enough value to justify the price.

The good news is that the IBM PCjr is heavily discounted at most IBM dealers. This is mostly the result of the intense competition in the retail computer business and the slowness of the PCjr to catch on with the public. In fact, some dealers are even giving the PCjr away if you also purchase a regular IBM PC. Here's your chance to turn your home into the proverbial home of the future for relatively little money.

Even better news is that the PCjr is not quite as difficult to upgrade as IBM intended it to be. A number of computer-accessory manufacturers are producing add-ons for it that promise to make this IBM games machine into a much more respectable computer.

Tecmar has been manufacturing add-on boards for the IBM PC since its early days. Now it has decided to focus some attention on the PCjr with several products that will make the jr. into a major league computer. One such add-on is the *jrWave*, that will allow the baby PC to add internal (RAM) memory up to its real 640K limit. This is as much as the PC itself can hold.

Legacy Technologies is already selling its *LEGACY I*, an expansion cabinet designed to hold ad-

ditional circuit boards, each of which will add to the PCjr's power. Legacy's other offerings include memory boards, drives, disk controller boards that allow the addition of floppy disk drives, clock/calendar boards and several types of output ports to allow the addition of still more equipment. The firm has even announced a 10MB hard disk drive, which should be available by the time this review appears.

Keytronic, maker of add-on keyboards for the PC and the XT, has added the KB5150jr and the KB5151jr keyboards to its line to solve the "chiclet" keyboard problem. Better yet, the KB5151jr has separate cursor control keys, allowing the user to enter numbers from the keypad and to do cursor control without the annoyance of switching back and forth between the two modes.

IBM did not choose a strategy that fits into the real world when it designed the PCjr. So if you want to stick with an all-IBM system you will not get much computer for your money. If, however, you are willing to shop around, find a good price on the PCjr., then add the necessary expansion units from other manufacturers, you could end up with a very nice system and pay less for it than you would if you bought the same configuration in a "real" PC.

International Business Machines, \$698 with 64K RAM; \$1,269 with 128K RAM and 320K disk drive; Cassette adapter, \$30; Internal modem, \$199; IBM PC Compact Printer, \$175; Carrying case, \$60; Joystick, \$40; Serial adapter cable, \$25; Parallel printer adapter, \$99; Keyboard cord, \$20

JUPITER ACE

What a strange little machine! That is the way most people react to the Jupiter Ace, and not without reason. The Ace is a computer-industry fad turned into hardware, a personal computer dedicated to the FORTH language. It's definitely not for everyone. But it's . . . well, interesting, at least.

The world of computers is at least as trendy as any other, and computer languages are especially prone to fads. Every now and then a language comes along and manages to attract the attention of respected computer scientists, writers in the field, and other trendsetters. Soon, computer programmers flow toward that language like ants to a picnic. Like people in any other profession, programmers always want to be first with anything new.

It happened with Pascal a few years ago. First came scholarly articles, then practical discussions. Soon, it seemed, everyone was shouting the praises of structured languages, and those still using BASIC were looked down on as barbarians.

Recently, MODULA-2, the successor to Pascal has been generating the same excitement.

FORTH appeared fully five years ago, and while it was really hot it filled the trade magazines for months. Today the excitement has more or less passed, and the language has become one more tool—something with recognized strengths and weaknesses to be used where appropriate, but not the panacea it once seemed.

FORTH is a really different language in many ways. First, you don't "write a program" in FORTH; you build words. Each word performs a given task, and once a word has been defined you can use it in the definition of another word. When you have built up a word that defines the total task you need done, you have your "program" written.

Second, everything in the FORTH language happens with stacks and Reverse Polish Notation, as with H-P calculators. Rather than go into technical details, let's just look at an example: In a normal calculator, to multiply 4 by 17 in normal notation, you type in:

```
4
×
17
=
```

and you get the answer. In RPN, however, you:

```
4
ENTER
17
=
```

and you get the answer. Easy, right? In BASIC, the program to do this would be: PRINT 4 + 17. In FORTH, the program would be:

```
4 17 + .
```

Some people get along quite well with FORTH. Most of the programmers in Atari's coin-operated game division use it. Also, people who get used to FORTH tend to think of it as a perfect language; it allows them to develop their own set of routines, or "words," and thus build a personalized language. What could be more perfect? Few go back to other languages once they make the jump to FORTH. Many others take a brief look at FORTH, however, and find they cannot think in the oddly backward, stack-oriented fashion this language requires.

FORTH carries RPN to extremes. It is nearly unreadable except to another FORTH'er. It is an extremely fast and compact language. In fact, FORTH is one of the few languages that can achieve good results with a small amount of memory. Many arcade game machines, for example, are programmed in FORTH for high speed and low memory requirements—the reasons it is so popular at Atari.

It is to aid in learning this powerful, fast, and very different language that the Jupiter Ace was devised. The result is a fine machine to find out about FORTH with, but at \$175, the price is a bit high for a casual experiment.

This is a tiny computer, about the same size as a Timex Sinclair—8 inches by 7 inches by 1 inch—and it weighs almost nothing. This is more than coincidence; the Jupiter's designers once worked with Sinclair, and this is basically the same machine. Inside is a powerful Z80 microprocessor, 8K of ROM containing the FORTH language, and 3K of memory, of which you can use about 1K for programs. The company offers 16K and 64K RAM expansion packs for the Ace. Although you can get more out of the basic 1K of free memory with FORTH than with most other languages, you will need at least 16K to do anything interesting.

The computer plugs into a standard TV set, and uses a character screen of 32 x 24. The characters are large and clearly formed. A display editor makes modifying and entering your FORTH source code easy. You may not like the keys particularly, which sometimes have a tendency to stick down and are not very solid. However, they are a step up from a simple membrane keyboard, as in the Atari 400.

You can do some limited graphics by reprogramming the character set—literally redrawing the character shapes displayed for a given character. This gives you a 256 x 192 graphics display in one color.

Connectors on the back of the machine allow you to add all sorts of peripheral devices. The makers are clearly trying to sell Aces for use as a dedicated control device in traffic signals, industrial machinery, and the like. What's neat is that FORTH is great for such applications; the Ace might be just the machine for anyone who needs a controller. The entire Z-80 pinout bus is available on the back, which is about as expandable as a computer can get.

There is a command to generate sound over several octaves, but it is rather crude compared to the complex synthesizers available on more powerful machines.

The company is also offering peripheral expansions, such as an IEEE interface, parallel and serial interfaces, and disk drives. This machine with 64K and the expansions would be quite a powerful computer, for FORTH is a powerful language in the hands of a person able to use it.

This is not a standard FORTH implementation, however. FORTH programmers are used to working with display-sized blocks of programs known

as screens; they are not used in this version of the language. The designers tried to make the machine as easy to learn as possible for folks whose experience is limited to BASIC or other languages. Some standard FORTH words are missing; their absence might infuriate a FORTH purist, but you can get by without them.

The company is also offering some software with the machine, such as an assembler, some FORTH tools, a monitor, spreadsheet calculator, word processor, lunar lander game, and even chess. Because they are written in FORTH, you can bet that they are fast.

It is difficult to draw firm conclusions about this computer. For someone who is used to RPN and wants to go through the process of learning FORTH, it would be a useful and probably a lot of fun. But it is a limited machine, and in the same price range—under \$300—you can also get a Commodore or Atari, with all sorts of software, color graphics, and sound.

What makes it even harder to recommend this machine is that both the Atari and Commodore have FORTHs available, some quite good. *Val-FORTH* for the Atari, for example, is an extremely powerful standard FORTH and a joy to work with. Add to this all the non-FORTH software available for these other machines, and they end up being much more useful, for the price, than this one. If the Ace cost \$75, as does a Timex/Sinclair, it might be a good buy. As things stand, it seems too expensive for what it offers.

Jupiter, \$175

LOBO MAX-80

The MAX-80 is one of those bridge machines that runs two seldom-united operating systems, providing a way for owners of a "home" computer to make the jump into serious business software without abandoning the programs and data files they already own. Primarily a CP/M computer, the Lobo also runs LDOS, one of the most popular alternative operating systems for the TRS-80 Models I and III. Nearly everything written for the Radio Shack machines will run under LDOS.

The Lobo itself is built into its keyboard housing, a box about 18 inches wide, 10 deep, and 3.5 high. Disk drives and screen are external and may be chosen on a "one-from-column-A" basis. Lobo sells both, but there is nothing to prevent you from using another company's products.

The system's heart is a Z-80A CPU. It runs at 5 MHz, not a lot faster than most other CP/M ma-

chines but enough to be noticed in the speed of video games and operations that require a lot of number crunching. It comes with 64K of memory, expandable to 128K. Two RS-232 serial ports and a Centronics parallel port are standard. Former Radio Shack users will welcome the Centronics port; it means they can still use the printer they bought for their old machine, connecting it with the same TRS-80 cable.

The MAX-80 comes with 64K of memory, all that the 8-bit processor can use at a given time. However, it can be expanded to 128K. If you use CP/M Plus—planned but not yet available as this is written—this extra memory can be used for bank-switched operation, where the CPU deals alternately with data in several different 32K segments of RAM. Or it can be used as a disk emulator, greatly speeding operations that move data to or from a disk frequently. Very little software is available to take advantage of bank switching; you will probably have to write your own programs, or at least customize existing ones—in order to gain much benefit from this feature. And a 64K disk emulator is a little small for many purposes. But a disk emulator of any size is useful enough to make the extra memory well worth having.

Mass storage is a Lobo specialty. The MAX-80 allows you to run four 8-inch disk drives, four 5¼-inch drives, and a hard disk simultaneously. The controller for the floppy disks is under software control, which allows the user to set the small drives to be compatible with disk formats used by Osborne and Xerox 820 single density drives and by the Omikron Mapper CP/M add-on for the TRS-80s. Such versatility is far from common. Maximum storage is 1.2 megabytes on each 8-inch drive and 328K on each 5¼-inch drive. Unfortunately, the Winchester drive port does not come with its own controller. The BIOS is set to use the Lobo Winchester controller, so it is best to be cautious in buying a hard disk for the MAX-80.

Lobo also manufactures disk drives—the firm began as a drive maker—and video screens, so it is possible to buy an entire system from them. However, just about any Shugart-compatible drive will work well. So will just about any CRT, provided that you pay proper attention to matching the specifications listed in the Lobo manual.

A very nice internal clock tells you the time and date when you log onto the system. The clock is powered by a battery, so that you never need to reset it when the power is off. As a matter of fact, the time is set at the factory so those in the Pacific Time Zone have to set the clock only during the seasonal change to daylight savings and back. The

clock will hold its time up to six weeks on battery power alone.

The keyboard has a nice, smooth touch, with a definite click when you hit the keys. The “F” and “J” keys have a slightly deeper indentation, so you can easily feel that your fingertips are correctly positioned on the home row without looking down to check. The big difference between this and many keyboards is that it has a teletype layout, like many of the systems designed before computers became a home appliance. A touch typist used to the IBM Selectric typewriter will have a little trouble adapting to the differences. It will not be as wrenching as changing to IBM’s own computer, however. There is no TAB key; tabbing requires a Control-I instead. This is a minor failing in an otherwise fine machine.

The keyboard is entirely software driven. This means that you can redesignate any of the non-shifted keys as you wish—even to the increasingly popular Dvorak style. A utility program is provided to make the change. It is also possible to design your own character set; this is a tedious process at best, but it can be done if you invest the time and some effort in carefully reading the manual.

Lobo’s manual is extensive and very comprehensive. They have documented everything about the machine with easy-to-follow descriptions of the different set-ups and how-tos. The layout of the manual is a bit confusing, but once you’ve learned Lobo’s filing system this is a good reference book.

The company has chosen to spare new computer users the task of wading through the CP/M manuals from Digital Research. Instead, they provide Thom Hogan’s *Osborne CP/M User Guide*, one of the clearest books yet written on this topic. If you choose the LDOS 5.1 operating system instead of CP/M, the Logical Systems manual is substituted.

Lobo has chosen probably the least popular marketing strategy in the computer business: They sell the MAX-80 themselves, by mail or telephone; you will not find it in your local computer store. They also support the machine themselves, through a toll-free service number. That sounds like marginal backup at best, but in practice it works well. It may be comforting to have your dealer nearby, but the chance that he knows as much about your machine as Lobo’s support staff does about the MAX-80 is pretty slim.

There is not much that can be said against the Lobo system. The test unit has proved totally reliable since it was purchased in January 1982—this though it has been used constantly and has occasionally bounced its way through California in the back of a car. It is a fine choice as a first machine, either for a small business or for home use.

Lobo Systems, \$995; with dual 5¼-inch drives and 12-inch green-screen monitor \$1,599; 64K RAM expansion \$95; 12-inch monochrome monitor \$175

MBC 550/555

Can Sanyo really be selling an IBM PC compatible computer for \$995? Well, no, not quite. Sanyo products are noted for good performance at modest cost, but in this case the performance is not everything you might hope. Don't buy this computer if you really want an IBM PC, but do consider it if low cost, color graphics, and bundled software appeal to you in their own right.

The MBC models consist of three components. The system unit contains the electronics and disk drives. It is only 15 inches wide and 14 deep. This small footprint makes it attractive for desktop use. Half-height disk drives give it a low 4⅝ inch profile; even with a standard 9-inch video display sitting on top, the entire computer is less than 15 inches high. The separate keyboard is wider than the system unit, but smaller than most competing models. Give Sanyo high marks for attaching the keyboard cable to the side of the system unit. This is a most convenient and aesthetically pleasing location.

The Sanyo's keys are in typewriter rather than computer layout and have large, easy-to-read legends. Most computer keyboards put the greater than (>) and less than (<) symbols above the period and comma, but the 555 gives them a separate key. As a result, the period and comma are always available in both upper- and lowercase. You will also appreciate the enormous Return key, fully four times the size of letter keys. To its right is a numeric keypad that doubles for cursor control, and on the far left are five Function keys. Despite the fact that the 555/550 has fewer function keys than other MS-DOS machines, a full 40 different commands are possible by using them in combinations with the Control, Alt, and various Shift keys.

Inside the system unit are an 8088 microprocessor, 128K bytes of RAM, 8K bytes of ROM, the video display circuitry, and a parallel printer interface. Sanyo's 8088 runs about 25 percent slower than its more expensive competitors, perhaps to allow the use of less expensive components. MBC 555 models include two single-sided, double-density (160K) floppy disk drives. The 550 has just one, but it may be upgraded. The memory on both models may be increased to 256K, and a serial port may be added. No other expansion is possible, because Sanyo does not provide space for plug-in options.

The video display offers some interesting contrasts. In text mode, it displays 25 lines of 80 characters, but the characters are not particularly clear.

Typically, the descenders—g, j, p, and q—merge with the tall letters of the line underneath, and both lines become hard to read. In graphics mode, the 555/550 can produce remarkable eight-color displays in a format 640 dots wide by 200 dots high. This is among the best color graphics available in a personal computer, but once again there are both advantages and problems.

The 555/550 has 48K of RAM for video display; 16K of that is actually part of the 128K available for programs. This enables the computer to display 640-by-200 monochrome graphics but reduces the usable memory to 122K and the maximum memory to 240K. Programs that need 256K, such as large spreadsheets, will not run on the Sanyo. The other 32K of the display memory provides the eight-color capability, but to see it you must have a high-quality RGB monitor. It seems unlikely that anyone buying the lowest cost MS-DOS computer would be willing to spend almost as much for a monitor as for the computer itself.

So, who would buy this computer? Perhaps someone interested in low-level business applications. Both Sanyo models come with powerful word processing (*WordStar*) and spreadsheet (*CalcStar*) software. The two-drive MBC 555 also comes with *WordStar's* proofreading and database cousins, *SpellStar* and *InfoStar*. Other popular MS-DOS packages like *Volkswriter*, *Perfect Writer*, and *Perfect Calc*, *dBASE II*, and *EasyWriter* will work, so 555/550 owners have a choice of software to handle routine office chores. However, the 555/550's low capacity, single-sided drives restrict them to small files. The limited memory also hurts; the new integrated software packages, such as *Lotus 1-2-3*, will not work on Sanyo personal computers. The 555/550 is never going to be the productivity tool that professional users are seeking.

What about home users? They are going to like the bundled software, since it quickly proves that their purchase can do something useful. They will also enjoy programming in *Sanyo BASIC*, which gives them access to the color graphics. *Sanyo BASIC* is similar to the *Microsoft BASICs* used on other MS-DOS machines—but, alas, not similar enough to run the many free programs available. Limited by the number of programs that will run on their machines, Sanyo owners may write their own software. Unfortunately, they will still find themselves isolated from the majority of the home computer users, because few other models support the Sanyo's unique features.

The 555/550 is not a computer that will let you trade programs with your friends (unless they also own a Sanyo); it is not a computer to put on every

manager's desk; and it is not a \$1,000 IBM PC. The 555/550 is a low-cost entry into the top end of home computers. It will run powerful, single-application word processing, financial, and database programs, and it will produce dazzling color graphics. If these capabilities fit your needs, the 555 may be for you.

Sanyo Business Systems Corp., MBC-550 \$995; MBC-555 \$1,395

RADIO SHACK MICRO COLOR COMPUTER

Prices of bare bones computers have been dropping, and Radio Shack has usually competed with other manufacturers for a part of that low-priced market. Their entry in that race is the MC-10 Micro Color Computer. It offers a sufficient range of elementary features to make it an ideal machine for beginners who are unsure of their commitment to computing as a hobby and don't want to spend a fortune to find out how involved they want to get. It also appeals to parents who want to introduce youngsters to computers but don't want to risk a more expensive computer during unsupervised operation.

Its size, a mere 2 inches high by 7 inches wide by 8½ inches deep, is less scary to the beginner or child and helps to ease them into using it without thinking of it as a challenge. Because it is small and has few peripherals, it is easy to install. You simply plug in its AC adapter and connect it to your TV's terminals. Then you're ready to compute. It is built around a 6803 8-bit microprocessor and has 4K of RAM built in. That may be increased to 20K with an external plug-in cartridge; its ROM is fixed and contains Microsoft Microcolor BASIC 1.0.

The MC-10 has a 47-key typewriter-style keyboard with chicklet-type keys which include multi-functions keys for BASIC commands, 16 graphics keys, plus Break and Control.

Its primary output is to a standard TV set through a built-in RF modulator, and up to nine colors are available if that set is color. It also has a voice with up to 255 tones that can be heard over the TV's speaker. Each tone can be varied in length from less than 0.1 of a second to just over 19 seconds, so the Micro Color Computer can play a wide range of simple tunes.

It isn't great for touch typing, because the keys are closely spaced and a few are in nonstandard positions. In normal operating mode it produces only capital letters, with graphics characters in Shift mode and Micro Color BASIC commands in Control mode; but you can select an upper/lower-

case operating mode by pressing Shift 0. The Reset button is at the back.

Its other means of input and output are a cassette port and an RS-232C serial port. The cassette port will work with any standard cassette recorder and the connecting cable is the same as the one used with some other Radio Shack computers. That cable offers connections for the mic, earphone, and remote control jacks on the recorders. The RS-232C connector is the standard EB-25 and is intended for a modem or a printer. There is a covered edge connector in the middle of the back panel onto which the external 16K RAM expansion is plugged.

The MC-10 has little software support from Radio Shack. The five packages listed in the catalog are Micro Color-checkers, Games Pak (*Lunar Lander*, *Breakout*, *Hangman*, and *Pong*), Math/Design (math, and plot graphics), Pinball (16K required), and Compac (communications package for CompuServe, etc.). However, its built-in BASIC is similar to the BASIC and *Extended Color BASIC* for the Radio Shack Color Computer except for the "tokens," a shorthand way of storing BASIC programs. Because of that similarity, some of the programs intended for use on the Color Computer (CoCo) may be easily revised to run on the MC-10 Micro Color Computer. Further, some of the magazines supporting the CoCo include programs specifically for the MC-10 or tell you how to modify programs intended for the CoCo. So, at least some software support does exist.

There are three commands not included in the documentation that would be of interest to the programmer or program developer. These are CLOADM, CSAVEM, and EXEC. They let you load, save, and transfer control to machine language programs at a specified address in memory.

With the popularity of the CoCo and the similarity of the MC-10's BASIC to the CoCo, the MC-10 with little specialized software support is not exactly the unloved orphan it might appear to be at first glance. However, it is limited by its keyboard, small memory, and limited expansion capability. Yet, it is a good machine for a beginner.

Radio Shack, \$79.95

SPECTRAVIDEO SV-318 AND SV-328

Spectravideo is a relative newcomer to the computer market. To date, it has specialized in low-priced machines. Their features stack up well against their competition, primarily the Atari and Commodore computers. But they have one disadvantage to consider, as well.

Spectravideo markets two models, the SV-318 and the SV-328. The 318 retails for \$299; the 328 retails for \$599. The two machines are nearly identical, only differing in keyboard and RAM size. (A very close analogy is the Atari 400 and 800 machines, with the 400 having 16K and a flat keyboard, and the 800 having 48K and full stroke keyboard.) If you plan on doing a great deal of typing, get the 328's better keyboard; the 318 is a strictly limited-use keyboard, without very good "feel" to it.

Both machines offer plug-in cartridges for instant software access. This is a very convenient way to use software and the cartridges are nearly indestructible, very different from a floppy disk or tape.

The Spectravideo has a Z80 processor, one of the most popular computer processors around. This is the same chip found in the Kaypro, Osborne, and other CP/M machines. It runs slightly slower than the now-standard 4 Mhz, but this should not affect operation much at the user level. The 318 has 16K of RAM, and the 328 has 32K of RAM. These machines can be expanded to a whopping 256K of RAM through a connector at the rear.

The Z-80 cannot access more than 64K directly. Hence, the 256K of memory, and video memory, are used indirectly, by only looking at 64K at a time, and varying which 64K is accessed. This technique allows for storing a great deal of code or other data in fast auxiliary memory and using it at high speed. If Spectravideo takes advantage of this capability, you will see some really fast software for this machine. There is a CP/M specifically for this sort of machine, called CP/M Plus, or "bank selected CP/M," and Spectravideo seems likely to offer it.

Both machines dedicate a further 16K of RAM to video displays, which is an impressive amount indeed; even the Atari machines, with their superb graphics, rarely dedicate more than 8K to user graphics. This added graphics memory spells great power in computer graphics. Sixteen colors are available in a 256-by-192 matrix of pixels. There's all kinds of power in the text modes as well; for instance, you can define graphics characters, then use them in text modes. This gives a resolution of 40×24 , with even finer resolutions available. There's even a mid-range mode with 64×48 pixels available, in the same powerful 16 colors.

Given that the Spectravideo machines are meant to drive a TV, and that televisions have a limited ability to display color and a limited number of lines to do it with, it is fair to say that the Spectravideo will drive a TV to its limits. In this capability it is the equal of the Atari machines, which first reached

this limit. It may even be superior because of its more powerful color capability; the Atari can only display four colors on any given TV line, versus the Spectravideo's 16. (Of course, which four colors the Atari displays can be changed from line to line, so this may not be much of a difference. In addition, in practice many of the 16 colors look alike; a TV just cannot display fine shades of color.)

The BASIC that comes with the SV machines is most powerful and uses the graphics ability of this machine to its limits. For instance, there are easy to use commands to draw points, lines, and circles. You can directly put values into video memory (which is not main memory, remember). There's even a "macro language" which is available from BASIC with high-speed, powerful graphics routines. If you are looking for a machine that will let you create graphic images on a TV, the Spectravideo offers you great power and easy access to this power. Most other machines force you into machine language to create these displays; the Spectravideo lets you do it from BASIC, an easy language to use.

The Spectravideo also makes use of "sprites." Sprites are independently programmable individual graphics objects. For instance, they could be a small character, ship, missile, cursor, or whatever. They are handled separately from the normal video image, which saves endless problems involved in mixing this independent image with a static background image. Many different sprites can be displayed simultaneously, and there is a lot of software support for detecting collisions between sprites—for instance, if a "missile" sprite hits a "ship" sprite. Even BASIC has this capability, which is unique among machines.

A powerful sound-generating facility allows you to program and control three independent sound registers. As there is a graphics "macro" facility, with high speed routines for BASIC to use in graphics, there is a sound "macro" facility to help generate sounds. The music and effects creation of this machine easily equal those of the Atari or Commodore machines, and may be even more powerful; the tools are great.

If you're programming the machine, you have a full on-screen editor. This nifty feature allows you to move a cursor on screen to the exact position of a line of code you wish to edit and just type in your new text. This is far superior to other editors, which often have strange commands and syntax. The Spectravideo editor is very easy to use. Incidentally, the joystick on the SV-318 can also be used to move the cursor around. This is a nice, straightforward approach to editing.

The BASIC is from Microsoft, the best-known name in BASICs, and it may be the most powerful BASIC the company has produced. It occupies a great deal of the 16K (318) or 32K (328) ROM in both machines, an unusually large amount of pres-tored memory for such a machine. This BASIC has a number of extensions over the usual BASIC, and includes everything seen in such other *Microsoft BASICs* as *AppleSoft*, *TRS-80 BASIC*, and *Atari Microsoft BASIC*. There's everything you could possibly need here, from machine language operators (mod, xor) to Swap (to exchange two variables) to statements for accessing the Z-80's input and out-put ports directly.

In this BASIC, eight bytes are used to store each number, which yields tremendous precision in calculation. Most computers use two or four bytes. However, because the computer must deal with eight bytes instead of four, everything slows down by more than a factor of two when you do numeric calculations. Expect great precision but not blind-ing speed. Still, in business applications, this pre-cision is most valuable.

A number of function keys can be programmed to replace a number of key-presses. For instance, if you need to type in the name of your company many times, you can program F1 to type that name automatically, and whenever you press F1 your company's name will be entered. With proper use, this can be a real timesaver.

With the 328, you get a crude but serviceable built-in word processor. It is stored in the machine, so when you turn on the Spectravideo it is ready. This is much like the Coleco Adam, but the Adam does not also give you BASIC immediately; it must be loaded in.

This word processor is pretty straightforward, with the usual screen editing, and block move com-mands (called "cut and paste" here, with keys by those labels). It is easy to set up a sample letter and print it out. There are limits, however; for instance, there is no automatic search and replace, as is found in the more powerful word processors. How-ever, since SpectraVideo offers CP/M for this ma-chine, you can always use *WordStar* or another CP/M program if you have a disk drive.

For storage, the Spectravideo offers both a tape drive and a disk drive. The tape drive is a pretty standard unit and offers the usual tape features: low cost and low speed. Similarly, the disk-drive mechanism is a standard single-sided, double-den-sity unit; it transfers data much more quickly than the tape. It holds 160K per diskette. Spectravideo, however, has chosen an oddball disk format that is not compatible with other CP/M machines, such as

the popular Osborne or Kaypro. Thus it has lost the chance to exchange disks with other computers.

Spectravideo also offers a number of peripherals for this machine. There's a modem, an RS-232 in-terface, an 80-column video board, a Centronics printer interface, RAM cartridges, and even a game adapter for Coleco machines, which use the same Z80 processor. Because these peripherals plug di-rectly into the Spectravideo Z80 bus, or parallel connector, they run at very high speed. These pe-riipherals can be used to expand the SV machines in the direction you wish. For instance, a modem is useful for dialing up bulletin boards or databases, an RS-232 port is useful for driving other printers, and an 80-column board is great for word process-ing.

By providing these functions in peripherals, Spectravideo lets each user custom-tailor their ma-chine and keeps the starting system cost quite low. Many of these peripherals are not even found on competing machines and are quite powerful; Spec-travideo has a computer here that can be many different things for many different applications.

In spite of its many attractive features, it is impos-sible to recommend purchasing the Spectravideo. In order to understand why, let's draw an analogy to buying a car.

Let's assume you buy a Chevrolet. The car may not offer the highest performance available; the handling may not be the best. In some ways, it can be overly difficult to drive around, and there are some features you would really like to see—a tilta-ble steering wheel, for instance. But there are lots of mechanics who know how to work on the Chev-rolet, and even if you break down in the middle of Nevada there is a good chance that the closest auto parts store will have the items needed to fix your Chevy.

In our analogy, the Chevy is an Atari, Apple, or similar popular machine.

Now let's assume you buy a Ferrari. First, this is a very high performance car. It handles like a dream. It is a pleasure to drive. But if you break down in mid-Nevada, it is unlikely that any local mechanic will have had any experience with the car and parts will be difficult to find.

Which car would you buy?

Now, let's further assume that the continued fi-nancial security and support of the Ferrari depends on how many people buy their cars. Would you buy a Ferrari if there was a possibility that no one else would and that the company will get out of the business?

Finally, let's assume that the Ferrari runs on a special kind of gas. In our analogy, this is software

written for the machine. How many dealers will stock this special gas if there are only a few Ferraris on the road? Not many. It is a chicken-and-egg situation; there must be cars (machines) on the road before anyone will stock gas (software) for them, but no one will buy these cars if there is no gas available.

Spectravideo seems to be caught in this trap. Make no mistake: This is a really good machine, with fine capabilities. But this machine has been out for a year now and has yet to appear in retail stores. Nor is a single piece of software written for the Spectravideo available in a software store, nor even advertised in magazines. This is a very bad sign for a very good machine.

In summary, the Spectravideo machine is a well designed, expandable, powerful computer. However, in today's market, this is not enough to ensure success. Only time will tell if Spectravideo can penetrate the under-\$500 market with this machine, and only time will tell if this machine will be a good buy. Without outside software support and a good user base, it will be an orphan machine; if enough are sold, and enough software is available, this would be a good machine to own.

Spectravideo, SV-318 \$299; SV-328 \$599; 64K RAM with built-in disk drive, \$649.95; with two drives, \$995; 64K RAM expansion \$109.95; RS-232 interface \$59.95; 80-column video board \$119.95

TRS-80 COLOR COMPUTER

When the TRS-80 Color Computer was introduced in 1981, the bottom-of-the-line computer was a 4K machine. Three years later, in 1984, the entry-level machine includes a 16K of memory—a 400 percent increase in capacity in just three years.

The CoCo, as it is affectionately called, was a little slow in catching on. Like the early Commodore Pet and T1-99 computers, which lacked full-stroke keyboards, the CoCo began with a "chicklet" keyboard. The resulting complaints led several independent companies to develop plug-in replacement keyboards, and when Tandy announced the Color Computer 2 in September 1983, it included an improved keyboard.

The Color Computer is aimed at the home-computer market—the same turbulent market Texas Instruments fled after reportedly losing several hundred million dollars. Atari, too, has suffered substantial losses, although Commodore and Tandy have been reporting profits.

The Color Computers' manuals provide ample documentation. There are three manuals provided with the Extended Basic computer. One covers

general operation and includes information about how to hook up the machine to your TV and cassette recorder. The second covers the commands available in Color BASIC, and the third manual is for Extended Color BASIC. A quick reference card, which covers both Color and Extended Color BASIC, is included, and a technical manual, which has schematic diagrams and explanations of the computer's theory of operation, is available.

The Color Computer series uses the Motorola 6809 microprocessor. The 16K Standard Color Computer 2 comes with 16K of user memory and 8K of ROM for Color Basic version 1.2. It has a 53-key typewriter-quality keyboard, a cassette interface, a serial port, two joystick ports, and a ROM port for program paks or a floppy-disk controller. A builtin RF modulator permits connection to any color TV set.

The 16K Extended Color Computer 2 includes an additional 8K of ROM. This additional ROM adds extensive graphics commands to the BASIC, which permit the use of the high-resolution graphics from BASIC programs.

The 16K Extended Basic Color Computer 2 increases memory to 64K. This allows programs up to 32K and permits the use of OS-9, a multiuser, multitasking disk operating system. When OS-9 is booted, the Color Computer 2 becomes a 64K RAM-based machine with the ROM turned off.

The CoCo's efficient design uses only 29 integrated circuits. Tandy has apparently put a lot of effort into quality control, since the machine is very reliable.

It is possible to begin with the 16K *Color BASIC* computer and then expand by adding the Extended BASIC ROMs. From there, you can add memory chips to get up to 64K of RAM. It is recommended that you do this before adding disk drives.

Many of the games available for the Color Computer require joysticks, and there are two kinds available. The standard joysticks are non-self-centering and are somewhat harder to use than the deluxe 2600 joysticks. The latter, which can be operated in either a self-centering or free mode, costs about three times as much as the standard joystick.

Any of the Color Computers can be modified to use floppy disks by adding a floppy-disk interface and a disk drive. The TRS-80 Model III 4 disk drives can be used. A multipak interface lets you connect four program paks or three program paks and the disk controller. A switch on the interface lets you select the pak of your choice, saving wear and tear on the program pak connector.

The machine accepts any printer with a serial interface, including Radio Shack's low-cost four-

color printer. This printer uses 4.5-inch paper and can be used for text as well as graphics. Since the characters are actually drawn with a pen, the printer can print only about 12 characters per second. The characters, however, are very legible.

A Graphics Input Tablet is also available. This device lets you create graphic images by drawing them on the tablet. Once the image is drawn, the Color Graphics Printer Ink Jet printer can print it out.

Color Basic is a very useful version of *Microsoft BASIC*. Variables in *Color BASIC* are floating point, single precision only. There is no option for integer or double precision. Commands are provided for CLOADing and CSAVEing programs to and from cassette tape. Low-resolution graphics are permitted using the "SET (x,y,c)" command, where "x" and "y" are the location, and "c" is the color. The screen resolution in this mode is 64 x 32. The eight colors available are green, yellow, blue, red, buff, cyan, magenta, and orange. The "SOUND t,d" command, where "t" is frequency and "d" is the duration of a sound, lets you generate musical tones. The stirring commands LEFTS, RIGHTS, and MIDS are also included.

Extended *Color BASIC* adds commands that permit the use of high-resolution graphics and also a number of other useful functions. Several high-resolution modes are available, from 128 x 96 in four colors to 256 x 192 in two colors. The "LINE (x1,y1)-(x2,y2)" command will draw a line from coordinates x1, y1 to x2, y2. The "CIRCLE (x,y), r,c,hw,start,end" command will draw a circle whose center is "x,y" with a radius of "r," a color of "c," and a height-to-width ratio of "hw." The "start" and "end" parameters can be any number from 0 to 1. If "start" and "end" are not specified, you get a complete circle. The "PAINT (x,y), c,b" command will fill in enclosed areas with a color of your choice, and a "DRAW" command lets you draw from the present location in any direction, including 45 angles. The color of the line to be drawn can be specified, and you can move the cursor without drawing.

The PLAY command lets you select musical notes from A to G and octaves from 1 to 5. The note length and tempo can also be selected.

An EDIT command allows you to correct a program line without retyping the entire line. Other advanced commands include: CLOADM and CSAVEM, for loading and saving machine language programs; trigonometric functions TAN, SIN, and COS; PRINT USING, for formatted output; and a built-in RENUM command. Hexadecimal and octal constants can be used with &Hnn for hexadecimal

numbers, and &Onn or &nn works for octal numbers. The function HEXS(n) will convert the number "n" to its hexadecimal equivalent.

Your first disk drive comes with a disk controller cartridge with Disk Extended BASIC in ROM, which permits formatting of blank disks to use 35 tracks for program storage. Though not as powerful as the disk operating systems on the TRS-80 Models III or 4, Disk Extended BASIC has all the functions needed for disk operation. Up to 15 files can be open simultaneously and you "LOAD" and "SAVE" programs using file-names. The disk operating system also keeps track of where to store and retrieve the information; the user need not be concerned with which track or sector the information is recorded on. If a disk has become partly unreadable, however, the built-in DISKIS and DISKOS commands, which permit reading and writing information from specified tracks and sectors, let you recover much of the data.

If you have a 64K Color Computer, you can use either FLEX or OS-9 as an alternate to the standard RS DOS. Both are excellent operating systems that have been used for some time on computers costing considerably more than the Color Computer 2. OS-9 is now supported by Radio Shack and will soon have much more low-cost software to run. BASICO9, also available from Radio Shack, is a compiled BASIC that is very fast.

A wide variety of games, including arcade favorites *Pacman*, *Donkey Kong*, *Pooyan*, and *Zaxxon*, are available from both Radio Shack and other independent vendors. There is also educational software, including Logo, an excellent first language for children. Logo is available in both rompak and disk versions. The Children's Television Workshop and Walt Disney have recently introduced a wide variety of software for children from ages 3 to 15.

Business programs are also plentiful, though they are limited by the 32 x 16 text screen format. One exception is *Telewriter 64*, which uses high-resolution graphics to display 24 lines of 51, 64, or 85 characters each. Of course you need a high-resolution monitor and a video adapter to use the 64 or 85 characters per line.

The Color Computer 2 is an excellent low-cost computer that can be expanded from a 16K cassette-based computer to a disk-based multiuser, multitasking system. Equally reassuring, you can go to any Radio Shack store for repairs, and there are a lot of Radio Shack stores.

The machine does have a few flaws, however. For one, the method used to implement the serial interface is not state of the art. The 6809 processor must scan the serial input line continuously to pre-

vent loss of data. This limits use of the Color Computer as a terminal to another computer. A new, deluxe communication program pak implements a serial port with a universal asynchronous receiver transmitter (UART). It also includes terminal software that is somewhat limited. This will undoubtedly be corrected by outside vendors.

The limited size of the text screen, which permits only 32 columns by 16 lines, is another deficiency. Though this can be improved by using characters generated on the high-resolution screen, it also takes quite a bit of memory.

Even so, if you are considering a home computer, the COCO should certainly be included in your evaluations and comparisons. It's hard to beat.

Radio Shack, 16K Standard Color Computer 2 \$159.95; 16K Extended Color Computer 2 \$199.95; 64K Extended Color Computer 2 \$259.95; 64K RAM kit upgrade \$69.95; Extended Color Basic ROM kit \$39.95; Multi-Pak Interface \$179.95; RS-232 Program Pak \$79.95; Joystick \$24.95; Deluxe Joystick, \$39.95; Color Mouse \$49.95; Disk Drive (first) \$399.95; Disk Drives (each additional) \$279.95; OS-9 \$69.95; BASIC-09 \$99.95

TRS-80 MODEL 4 AND 4P

The TRS-80 Model 4 and 4P would undoubtedly lead Charles Darwin to conclude that the same theory of evolution he propounded for living species also applies to successful third-generation hardware. The current TRS-80 Model 4 and 4P (the portable version) are direct descendants of the original TRS-80 Model I, with 4K RAM and Level I BASIC, and the line has survived by adapting to the environment—in this case, user desires and competitive pressures in the marketplace.

The evolution has proceeded smoothly: Both machines offer the user relatively little cause for complaint. They are among the best choices available for the serious personal-computer user and will also suffice for many small-business applications where budgets are tight or exceptional power is not really needed.

One of the things you want in a computer is a bountiful supply of low-cost, high-quality software. Model 4 and up will run virtually all the software ever created for the Model III by running in a Model III mode. In that mode, most of the Model I software can also run. Collectively, that is a lot of software, but there's even more. Radio Shack also designed the Model 4's to run CP/M software, which opens the door to what is probably the largest body of software in existence. So if you don't like Radio

Shack's *Scriptsit* word-processor family or any of the dozen or so word processors independently written for the TRS-80 operating system, then you can choose from among *WordStar*, *Peachtext*, and other CP/M programs.

The Model 4 is a self-contained buff-colored unit that will fit into the decor of either home or office. The screen is a black-and-white display of 24 lines by 80 columns (16 by 64 in Model-III mode) and also provides an expanded character display of either 32 or 40 characters, depending on the mode of operation.

There is internal space for two single-sided, double-density, full-height, horizontally mounted mini-floppy disk drives of 184K each. Four double-sided, double-density, half-height drives (as in the Model 4P) would have been a better use of the space, but you can't have everything.

The keyboard is a typewriter-style layout with 70 keys, and there's a separate numeric keypad, a Control key, a Caps key, and three programmable special-function keys, which are used in some of the new software, such as *Scriptsit* and *Multiplan*. The keys have a nice feel and there is a software-controlled audible click that can be toggled on or off.

External connections include a cassette port, a Centronics-type parallel-printer port, an RS-232 serial port (standard in the two-drive version, optional in the one-drive and cassette versions), a connection for two additional external disk drives, and a bus that will allow connection of Winchester-type hard-disk drives, real-time clocks, music or voice synthesizers, and other devices.

At the center of things is a Z-80A 8-bit processor that runs at 4MHz in the Model 4 mode and 2MHz in the Model III mode. Despite the 4MHz clock speed, however, the system is slowed somewhat because early Model 4Ps were modified to run with two processor wait states when addressing memory. Later Model 4Ps improved this to one wait state, and the Model 4P runs with zero wait states.

The cassette-only entry model comes with 16K RAM, and the one- and two-drive versions come with 64K RAM, expandable to 128K. This allows 64K to be organized as a RAM disk and operated as a virtual disk drive. Virtual-disk-drive operation enhances the performance of *Multiplan* and *SuperScriptsit* considerably. In addition, the entire operating system can be installed in RAM disk, which improves all operations requiring access to the DOS utilities and library functions.

The Model 4 also contains 14K of ROM for its operation in the Model III mode. When operating in the Model 4 mode, the ROM is switched out so that

the entire 64K of RAM can be addressed. There is no cooling fan, but the convection cooling is adequate, which means the machine is also quiet.

While many users do not care about operating systems, those who do will be happy with the choices the Model 4 offers. There are seven operating systems—all of them good. In the Model III mode, there's TRSDOS 1.3, LDOS, DOSPLUS, NEWDOS 80, or MULTIDOS. Of these, TRSDOS 1.3 is above average, and LDOS is particularly excellent.

In the Model 4 mode, there's TRSDOS 6.0 (an excellent adaptation of LDOS), DOSPLUS 4.0, or CP/M operating system—either Radio Shack's CP/M Plus or Montezuma Micro's CP/M 2.2. CP/M is a mediocre operating system as operating systems go. It was laid down years ago, and its progress has been retarded in the interests of standardization. But there is a lot of software available for CP/M (much of it in the public domain and free), and there are many who are familiar with it, so CP/M is a definite plus.

The BASIC furnished with the Model 4 is by Microsoft. In the cassette version, it is essentially the "Level II" BASIC—a powerful set that contains most everything one will need. In the disk versions and Model III mode, a disk BASIC loaded from disk supplements the ROM BASIC. In the Model 4 mode, the ROM BASIC is not used and Microsoft 5.0 BASIC is loaded from disk. That version adds the capabilities of long variable names, chaining, global variables, and several other functions not found in the Model III ROM + Disk version.

Competent editor assemblers; BASIC compilers; C compilers; and COBOL, FORTRAN, and Pascal compilers are available, though some of these operate only in the Model III mode. Alcor Pascal and C compilers are already available for the Model 4 mode, and Radio Shack has announced that BASIC and FORTRAN compilers will soon be available.

The expansion capabilities are more than adequate for an 8-bit processor computer. Starting with the 16K cassette-based machine, a user can eventually build up to 128K RAM and either four floppy-disk drives or four Winchester hard disk drives, with 5 megabytes per drive if he opts for the Radio Shack drives, or up to 15 megabytes per drive if he chooses a third-party vendor.

There is a high-resolution graphics package soon to be available that includes an extension to BASIC for graphics commands and provides the screen display with a resolution of 153,600 pixels.

With the Centronics parallel-printer port and a standard RS-232 serial port, the Model 4 is compatible with a nearly endless variety of printers, plot-

ters, and modems, both from Radio Shack and other vendors.

With both TRSDOS and CP/M operating systems available, the Model 4 can run an almost endless number of programs. Tandy has also changed its earlier policy of selling mostly Radio Shack brand software; the company is now offering an increasing number of software packages that have become popular on other machines. Whereas once about the only "name" package Radio Shack offered was *VisiCalc*, they now offer the PRS series, *Multiplan*, *Desktop/Plan-80*, and others.

Of course, you can't run any IBM PC software, but between TRSDOS and CP/M, you are well covered. And with the 4MHz CPU, programs generally run about as fast—or even faster—on the Model 4 as on the PC.

In general, the Model 4P, a portable machine, performs like the Model 4. There are, however, a few significant differences. The most obvious differences between the two machines are in appearance. The 4P's keyboard is detachable, the display is a 9-inch black-and-white screen, the two built-in disk drives are half-height, and the whole business fits together in a compact 26-pound package, with a handle for carrying. A 9-inch screen may sound small, but what it lacks in size, it more than makes up with crisp, legible characters.

The half-height floppies have the same capacity as the 4's, but there is no connection for additional floppies. You can add an external Winchester, but even so, this is an unfortunate oversight. Though many users may be satisfied with two drives while "on the road," they will want to use more when back at the office or at home—particularly when the TRSDOS 6.0 or LDOS permits the use of double-sided 40—and 80-track floppies. Two half-height double-sided 80-track drives can provide 1.4 megabytes in a small and fairly economical package. The 4P also offers an option of a built-in modem, which may be an advantage to those who use the 4P principally as a portable.

In the Model 4, there is about 14K of ROM, devoted to BASIC and some other matters, that is either used or switched out, depending on whether you are operating in the Model III or Model 4 mode. The 4P omits this ROM and provides for Model III mode by software that loads the ROM code from disk into the equivalent RAM. This means that if you have a Model III disk you want to run, you can't just shove it in and boot the machine. You either have to have already loaded the ROM equivalent or have it on the Model III program disk you want to run. It is a minor inconvenience and probably won't bother many folks. Otherwise, the 4P is about the

same as the 4; both machines use the software, peripherals, and languages.

One advantage of purchasing a computer from Radio Shack is the availability of service, the abundance of software, and the availability of technical information on the system. There are three major magazines devoted to TRS-80 computers, and the operating systems have been dissected bit by bit by users. As a result, there is little that is unknown about the Model I/III/4 computer.

All major cities now have a Radio Shack Computer Center (RSCC), and generally each RSCC has a repair department. There are also user groups, with expert users scattered everywhere. Many times these experts can answer questions that cannot be answered by RSCC personnel.

On the flip side of the coin, Radio Shack has not always been prompt in making new versions of software available. TRSDOS 6.0, for example, was released by LSI in July 1983, but as of February 1984 was not yet available from Radio Shack as a free upgrade package for TRSDOS 6.0.

Such quibbles aside, the Model 4 and 4P are among the best things that Tandy has done, and they are competitive with anything in their class. If you are considering an 8-bit machine, look at these two before you go anywhere else.

Radio Shack, Model 4 16K cassette version \$999; CCR-81 Cassette Recorder \$59.95; Model 4 64K 1-Disk (no RS-232) \$1,699; Model 4 64K 2-Disk (w/RS-232) \$1,999; 5 mb hard disk (1st) \$1,999; 5 mb hard disk (2nd) \$1,799; high-res graphics board & S/W \$249.95; CP/M Plus DOS \$149.95; Model 4P 64K 2-Disk \$1,799; Model 4P modem board \$149.95; 64K RAM expansion \$79.95

ZENITH

One of the newer Zenith models is the Z-29, compatible with many software environments which use ANSI protocol terminals, including the DEC VT-52, Zenith's own Z-19, Lear Siegler ADM-3A, Hazeltine 1500, and it emulates many DEC VT-100 features. It is microprocessor-based (Intel 8051) for screen control intelligence. It also has a tiltable 12-inch green monitor on which you can display graphics, including bar charts and graphs, using 33 symbol characters. An alternate character set adds superscripts and subscripts, Greek symbols, and VT-100 graphics. The keyboard includes 90 function keys, plus a 14-key numeric pad and audible key clicks, plus optional keyboard palm rest for comfort. A "rate advance" cursor repeats a character faster the longer the key is depressed.

Another Zenith terminal, ZT-1 Personal Information Terminal, is very friendly—it can dial computer banks such as The Source and CompuServe and 26 phone numbers at the touch of a button. It can even answer your phone! Once you plug ZT-1 into a standard modular telephone jack, and select an information source from the menu that instantly appears, you just push one button and ZT-1 puts you in touch with the computer database you've selected.

In fact, Model ZT-1 comes with a special subscription offer from CompuServe, while Model ZT-1A includes offers from The Source and Dow Jones. Both models make it easy to log-on to their respective databanks. These ease-of-use features eliminate the need to remember complex codes.

ZT-1 also makes it easy for you to store up to 26 phone numbers, dial them automatically, and store other pieces of information, such as account numbers and passwords. The communications capabilities of ZT-1 come from the 300-baud mode that's built in. The memory is protected by a battery-powered back-up which, if properly recharged, will retain information for up to five years.

Zenith also makes sure you understand all the instructions on the screen and requests for information, so it has made sure to communicate with users in plain English. The company has also made sure to give you a HELP key to let you tell ZT-1 when you need further assistance.

The monitor is a 12-inch green phosphor displaying 25 lines by 80 columns. The keyboard has 63 keys, including four cursor keys. The space these elements take up is a mere 16 inches in desktop depth—the unit was designed to absorb a minimum of space.

The 4½-pound keyboard can be ported anywhere and plugged in wherever there's a monitor and modular phone jack because the unit is a telecomputing system. In this way, you gain complete access to computer databases wherever you are! The unit can also connect directly to a parallel-type printer.

ZT-1 models are compatible with DEC VT-52. The modem is compatible with Bell 103. The rate of transmission from host computers to the terminal can reach 4.8 k baud.

Still another Zenith terminal, Z-49, has great compatibility features—DEC VT-100 and VT-52, plus DEC's VAX and PDP minicomputers, and Zenith's own ZDS (Zenith Data Systems) Z-19 and Z-29. It also has the very nice feature of a 14-inch screen. That screen comes in amber, nonglare, but a Z-49G is also available at no extra charge with a green screen.

Additional features of this jam-packed machine are a printer port, two-position monitor tilt and nine user-programmable function keys. Z-49 also has a non-volatile memory to store terminal configuration. Seven foreign character sets are part of the 256 standard characters, plus 31 special Greek symbols and advanced graphics characters. The terminal also allows you to draw double-high, double-wide characters.

The keyboard holds 92 keys on a low-profile unit and adds a 6-foot coiled cable so you can move the keyboard around a lot.

The Z-49 also has a special feature—a self-test procedure performed whenever the terminal is turned on. A “beep” sound lets the user know everything’s OK. A screen-saver turns the display off after 15 minutes of non-use, so images don’t burn into the screen phosphors.

An advanced video option gives you 132 columns with 25 lines, DEC video attributes, and three brightness levels—bold, normal and dim.

Zenith Data Systems, Z-49 \$849; ZTX-1 without monitor \$449; with monitor \$549; Z-49 \$1,099

PERSONAL COMPUTERS FROM \$1,000-\$2,000

COMMODORE 8032

It is not often you see this computer anymore. Newer, cheaper systems with better-sounding specifications have surpassed it long ago. Introduced in 1980, it was Commodore's first serious entry into the business computer market. Yet it remains in production—Commodore points out that it has never discontinued any of its products—and it still is found occasionally in well-established computer shops.

The 8032 remains a staple of Commodore's line. Like the earlier PET computer, the 8032 is a 6502 machine, a single unit containing a keyboard with a numeric keypad, good for accounting, and a 12-inch green monitor. Appropriately named, the 8032 displays 80 columns of characters and comes with 32K bytes of memory. This is rather limited by current standards. Still, the user gets exactly what is promised, almost 32,000 bytes of memory, because the computer's operating system does not eat up any of the user's memory. This contrasts with many other computers, including the popular Commodore 64 which gives the user only about 38K bytes of useable memory, instead of the 64K bytes as suggested in the name.

Another primary consideration in business computers is the readability of the print on the screen, and here the 8032 deserves an "A." The letters are sufficiently large and the screen can be brightened or dimmed as needed. However, the screen cannot be moved without shifting the entire unit. This makes it hard to avoid the reflection of harsh overhead light. Some computer screens have a plastic mesh stretched over the glass surface to reduce glare. The 8032 does not. These are critical details, because one of the most frequent complaints by those using word processors is visual fatigue, to which glare contributes.

Where the CBM 8032 excels is in its editing system. It permits the user to move the cursor around easily and quickly, and to insert a missing character, delete an extra character, or print over an incorrect character. These are fundamental editing features, and the 8032 handles them all with dedicated control keys. Each of these keys has an auto-repeat feature, which saves time. Additional editing features, such as moving lines or paragraphs around within the text, are dependent upon the word processing program itself. Probably the most popular for this machine is *WordPro 4 Plus*.

The CBM 8032 keyboard resembles the standard typewriter keyboard in its general layout and spac-

ing, but there are differences worth considering. The CBM's keyboard is stepped rather than sculpted; computer users will not find this bothersome as many terminals use the same arrangement, but a typist may well find it uncomfortable after the careful design of a sophisticated typewriter. Even more serious, some key functions are not located where you would expect them. Normally, for example, the colon and semicolon are on the same key in the third row; on the 8032's keyboard, the colon is located in the top row. To a novice typist these aberrations probably don't matter, but they would be likely to frustrate the experienced.

The CBM 8050 disk subsystem consists of two drives in a single cabinet. This device is connected to the IEEE 488 parallel port on the 8032, and data transfer is very fast. The best feature of the 8050 is that each drive can write almost 500K bytes on each disk—a total of one megabyte. Even today, most single-head disk drives can record less than 400K bytes, and the IBM PC is limited to 360K, or even 320K, depending on the operating system used. It's much quicker and easier to manipulate data or text stored on a single disk, rather than spread across multiple disks. What's more, even though the manufacturer recommends using double density 5¼-inch disks, many users report that the slightly cheaper single-density disks work just fine.

The 8032 does suffer some severe disadvantages when compared with more modern equipment. For one thing, 32K is not much memory—only enough for limited word processing or a very small spreadsheet. For another, you will never be able to trade disks with anyone else; the 8050's format is not compatible, even with other CBM systems. It's relatively expensive; an equally functional computer designed today would cost far less than half the 8032's original list price. And though Commodore may still build a few 8032s, you cannot expect much support for them.

Most important, perhaps, very little software is available for this system, much less than for CP/M-based systems or the IBM PC. Nevertheless, it is not difficult to locate perfectly adequate word processing, electronic spreadsheet, or database management programs. *Wordpro 4 Plus* manages to make the old Commodores into far better word processors than anyone could hope—much better, in fact, than most CP/M or MS DOS processors. And the original *VisiCalc* is available for the 8032.

There are many computers available today that most people would probably prefer to these venerable near-antiques. Yet the CBM 8032 and 8050 disk drive remain a reasonable system for limited home or business use. If your local dealer runs across a forgotten one in his stock room and offers it at a deep discount, it's worth considering.

Commodore Business Machines, 8032 \$1,495

CROMEMCO C-10

The Cromemco name is not as widely known to the personal computer user as it might be, largely because a fair percentage of the company's products are sold to original equipment manufacturers for incorporation into other products. But the C-10 is highly regarded by engineers and others who require math and scientific applications. It is being used by the *Wall Street Journal*, the Chicago Mercantile Exchange, and the United States Air Force. The C-10 cannot be a toy with references like those, or with the backing of a company whose pedigree is as respectable as Cromemco's.

Cromemco is the oldest company in the United States dedicated to the design and manufacture of microcomputers. It was founded in 1975 and incorporated the following year. Cromemco engineered the first color graphics adapter for a microcomputer, worked on the development of the S-100 bus, and developed both the first 8-inch Winchester hard-disk drive and the first 5¼-inch floppy-disk drive for micros.

The C-10 is Cromemco's first low-priced computer. It employs a Z80 8-bit CPU and comes with 32K of ROM and 64K of RAM, of which the operating system occupies about 8K. The resulting transient program area is 56K of actual working space. The computer itself is built into the monitor and comes with one stand-alone dual-sided 5¼-inch disk drive. The keyboard is separate, and two models are offered: the CKBA, a simple Qwerty keyboard laid out like the IBM Selectric, with the addition of several needed keys, and a hidden numeric keypad available to the user; and the CKBC, which adds to it a numeric keypad and 20 function keys that allow a total of 40 function codes. Both keyboards feature key click and automatic character repetition.

There are no expansion slots, but the C-10 includes virtually everything one might need. It comes with an RS 232 port, serial and parallel printer ports, and a disk-drive port for adding extra

external disk drives. The two basic packages include the computer/monitor, disk drive, and keyboard. The C-10SP package includes Cromemco's own software, including a good word-processing program, a page-oriented spreadsheet program, and some others. The C-10MP also includes software put out by Micro-Pro, including *WordStar*, *CalcStar*, *InfoStar* and *MailMerge*; a \$1,400 retail package, it goes for \$400 with this computer. Either package can substitute the enhanced keyboard for \$200.

The operating system and indeed the entire user interface system is designed for the first-time user. Cromemco is reported to have good support services, and their machines are serviced by TRW nationwide as well. The operating system, a version of CP/M, is menu-driven and all programs and utilities are on the system disk. The system recognizes the user's configuration—when one adds additional disk drives, the system automatically changes the directions to the user to reflect that addition. The use of CP/M means that most popular programs, like *SuperCalc* and *dBASE II* run on the Cromemco.

If one uses Cromemco's *Write Master* word-processing program, all format functions are carried out on screen—underlining, bold, and so on—so that what you see is what you get, with no extraneous marks. Cromemco also allows for scientific notation, graphics, sub- and superscript, and provides autosearch and replace. Those added character sets are available for program and software development purposes as well. Their additional software, most of it priced at around \$295, includes *Spell Master*, which uses a 100,000-word dictionary—10,000 more can be added by the user—and shows a misspelled word, offers its guess for the proper spelling and, upon the user's okay, replaces it, all in one pass. Most spelling checkers are more cumbersome in use. There are also *Stat Master* for statistical analysis, *Tele Master* for communications, and program applications like a macro assembler, a Cobol compiler, Fortran IV, RATFOR, and LISP.

In addition to being a quality personal computer at a very reasonable price, the C-10 can act as an intelligent workstation in a multitasking, multiuser environment. There is a great deal of talk about 8-bit versus 16-bit CPUs. For many users, an 8-bit processor is lazing along when performing the most complicated tasks they can assign it. If one needs massive amounts of speed, however, the C-

10 can be tied into Cromemco's giant System 68000 through the RS-232 port. It can work as a stand-alone, and upload or download within the 68000/CROMIX context.

Cromemco designed CROMIX before UNIX was licensed for use on micros; now that UNIX is available, Cromemco will soon have it for use with the C-10. In this environment, one could prepare data which would eventually be entered into the larger computer, store it temporarily on disk, and upload at will. An office could start with several C-10s and in time tie them all together into the 68000/UNIX network. In that network, a person could compose a memo and, at a keystroke, arrange to have the memo sent to the 68000, and have the 68000 send the memo via modem to all the satellite offices around the country. That is microcomputing at high efficiency.

In the 68000/UNIX network, the C-10 will support Fortran 77, full GSA certified COBOL, C, 68000 Assembler, and Pascal, and will address up to 16 megabytes of error-correcting memory. As with any network, an office could share several different high-speed printers, for instance, and have documents queue up to be printed on a choice of printers. A disk with data recorded on the C-10 will be readable by the Cromemco 68000 and vice versa, and there is complete compatibility up and down the product line between the C-10 and the 68000 D series of Cromemco products.

The Cromemco C-10 is a good choice for someone getting started with micros. Its ease of operation, its reasonable price, its ability to be tied into a powerful network, and its manufacture by an established company recognized as a pioneer all should provide the user with assurances of quality and satisfaction.

Cromemco, C-10 SP (SuperPak) with monochrome monitor, computer, keyboard, dual sided 5¼-inch floppy drive, and Cromemco software \$1,785; C-10 MP (MicroPak) adds *MicroPro* software to the above package \$2,185; upgrade to the CKBC keyboard \$200; Cromemco Daisy Wheel printer \$795

EAGLE IIE

At a time when removable keyboards and stand-alone monitors are the rule for practically every desktop computer, these 8-bit Eagles may strike hardware worshippers as ancient. While some may find it a mistake to pack the keyboard, screen, disk drives, and everything else into something resembling an overgrown terminal, for many office and classroom situations one-piece computers may ac-

tually offer advantages: They are compact, simple, and easy to set up.

The Eagle IIE series is among the best of this type. The 12-inch green phosphor screen has a no-glare filter and is eminently clear and readable. The 75-key typewriter keyboard is comfortable, with a positive action and a numeric keypad at the right that eases data entry for accounting and similar chores. The placement and design of both are convenient, despite being in a fixed position.

The four models in the IIE series, IIE-1 through -4, use the Z80A microprocessor operating at 4MHz clock rate and contain 64K RAM. Save for the IIE-1, they come bundled with enough software to handle many standard office chores: the *Spellbinder* word processing program, *Ultracalc* spreadsheet, *CBASIC* language, as well as the CP/M 2.2 operating system.

The models differ primarily in storage capacity. The IIE-1 is basically a smart terminal with a single 5¼-inch floppy disk drive, a quad density (96 tracks per inch), single-side device with a storage capacity of 390K. The Eagle IIE-2 is the most popular model, with two 390K disk drives, for a total storage capacity of 780K. The disk capacity of the IIE-3 is twice that of the IIE-2; its two double-sided quad density drives each have 780K capacity for a total of 1.56 megabytes. The IIE-4 has an internal 10 megabyte Winchester hard disk plus a 780K double-sided floppy drive.

Two serial RS-232 ports and a parallel Centronics printer port are supplemented by a second parallel I/O port on the IIE1-3 models, ready for an outboard hard disk. Options available from Eagle include the File 10 (10MB) and the File 40 (40MB) hard disks. The Eagle IIE-4, with a 10MB internal hard disk, has a Winchester add-on port for externally adding a second hard disk without a controller. It also boasts an interface port compatible with the Shugart Associates System Interface. This allows further expansion.

Eagle has intelligently customized their word processing software and computer hardware to work together. The result makes the Eagle IIE look and behave remarkably like a dedicated word processor. When using Eagle's specially modified version of *Spellbinder*, 32 marked pre-programmed keys are set up to perform practically all of the important word processing commands with a single keystroke. When not running *Spellbinder* the keys revert to their ordinary keyboard functions.

As a word processor, the Eagle IIE-*Spellbinder* combination gets high marks for ease of learning and use. It is possible to create a document in memory and print it out without having to save the

work in a disk file—good for a quick envelope, letter, or memo. Moving a block of text is a simple dedicated-key operation. Instead of being limited to single-character movement, the cursor can be controlled to skip from word to word, sentence to sentence, or paragraph to paragraph. Configurable print tables permit the use of true proportional spacing with precision daisy wheel printers. When typing a document longer than eight pages or so, the memory buffer fills to capacity, so that the user must set *Spellbinder* to write and read the text to and from disk.

Most of the function keys are virtually self-explanatory, but a few of the features need documentation. The documentation is quite voluminous and not organized for easy reference, a shortcoming unless the new user resolves to undertake learning from a formidably long tutorial. Part of the problem is that Eagle chose not to furnish the original documentation from Lexisoft, the makers of *Spellbinder*. Sad to say, many of *Spellbinder*'s advanced attributes are poorly explained, and some go unmentioned. Despite these problems, however, the *Spellbinder* implementation on Eagle IIE systems makes them among the best word processing buys on the market.

It is possible to use an Eagle IIE productively without ever learning CP/M commands. That's because most of its disk utilities are menu-driven. Thus, one can format and copy disks as well as boot in programs and never see the "A" prompt. This is fine until the user, who thinks the system has been mastered, needs functions that aren't on the menu. Copying files with the PIP utility and using STAT are examples. So is running a newly-acquired program. Such "friendly" implementations have their limitations.

The cursor keys provide another surprise when running non-bundled software. They are actually numeric keypad keys, dedicated to the cursor in *Spellbinder*. When other software is used, the cursor must be moved by control-key commands. However, such annoyances are common with other computer systems.

All told, the Eagle IIE models are well thought-out systems with a good repair record. Using direct memory access for fast floppy disk operations, they run software smoothly and quickly. Originally designed as a master control unit to operate up to 120 slide projectors in multi-image displays, when implemented as a business machine the Eagle IIE series gives no hint of being mere afterthought. Now selling at prices far less than when first introduced, they represent a good value.

It is rumored that the Eagle IIE series will soon be

discontinued. This would represent the loss from the marketplace of some of the best-engineered 8-bit single-board systems now available.

Eagle Computer, IIE-1 \$1,495; IIE-2 \$2,495; IIE-3 \$2,995; IIE-4 \$4,495; File 10 \$2,495; File 40 \$3,995

FRANKLIN CX SERIES

If you ever thought it would be nice to run programs written for CP/M, MS-DOS, and Apple DOS all on a single computer, you might like to take a look at the Franklin CX series. You may or may not like what you see here, but you should at least find it intriguing.

A little background first. The original Franklin ACE was a straightforward Apple II clone and was marketed that way—as a less expensive alternative to the Apple. The ACE was so much a clone, in fact, that Apple eventually sued Franklin for copyright infringement. The litigation ended when Franklin agreed to develop its own operating system, Franklin DOS. The ACE series still exists as a desktop system not very different from the now defunct Apple II plus. It is sold with Franklin DOS, or F-DOS, which Franklin claims is a significant improvement over Apple DOS 3.3. (Apple's current operating system for the Apple IIe is ProDOS.)

Franklin's new CX Series is essentially a reworked version of the ACE 1200. It is compatible with the Apple II Plus and also comes with the new Franklin DOS. According to Franklin, however, it is not meant to replace the ACE line. The CX computers are portable systems, not desktop computers, and they are meant to compete in a different market.

Depending on your point of view, the CX Series is either four different computers, or four different configurations of a single computer. The second description seems more accurate, as you can add options that effectively erase the distinctions between models.

The basic CX, or CX-1, is a box 15 inches by 17 inches by 6 inches, which gives it about one third the footprint of the Compaq and lets it fit easily under an airplane seat. At roughly 25 pounds, the CX-1 is a bit too heavy to be easily portable, but is still lighter than most transportable computers. It has 64K RAM, a 1 megahertz 6502 CPU, a built in 7-inch screen, and one double-sided, double-density disk drive. The CX-1 also includes serial and parallel ports, an 80-column display card, and color capability all as standard equipment.

Like the ACE 1200, it comes with Franklin DOS, which makes it compatible with the Apple II Plus. It also comes bundled with a program called the

Franklin Office Manager. This is an integrated software package that includes a word processor, spreadsheet, spelling checker, and graphics capabilities. As with other integrated software, the *Franklin Office Manager* provides a single command structure for all four programs and will let you transfer data from one application to another.

At \$1,395, the CX-1 is directly competitive with the Apple IIc. The Apple lists for about \$100 less than the CX-1, but it has almost no capacity for expansion. This Franklin's expansion capability is probably worth the extra cost even if you have no immediate plans to take advantage of it.

Add a second double-sided, double-density disk drive, and the CX-1 becomes the CX-2. Be aware that this is the minimum configuration you should start with if you can possibly afford it. Single-drive systems are a major chore to work with and should be avoided whenever possible. The difference in price between the two systems is only \$300, and the difference in convenience is well worth the cost.

The next most expensive version of the CX is the CX-2C; the added C indicates that this runs the CP/M operating system as well. To convert the CX-2 to the CX-2C, you add a card that carries a 6 megahertz Z-80 CPU and its own 64K of RAM. You also add the CP/M operating system, of course, and *CBASIC* and *WordStar* fill out the package.

The last, and most expensive, version of the CX is the CX-2M, which runs the MS-DOS system as well as Apple programs. The MS-DOS card supplies a 5 megahertz 8086 CPU and 128K RAM. Then, of course, you add the MS-DOS operating system, and Franklin supplies a 16-bit version of BASIC and the 16-bit version of *WordStar*. Finally, add Franklin's Universal Disk Controller, which lets you read and write additional disk formats, including a double-density, double-sided format, KayPro single-sided double-density format, Osborne single-density format, Osborne double-density format, IBM single-density format, and IBM double-density format.

You can also create a single CX computer that runs all three operating systems—F-DOS, CP/M, and MS-DOS. All you have to do is add all the available options. Just why Franklin has not officially added this configuration as the fifth member of its line is not clear.

Franklin also offers three important options that don't come as standard on any version of the CX system. These are: a 110/300 baud direct connect modem, a soft case carrying case, and a memory upgrade to 256K RAM for use with the MS-DOS option. The modem is compatible with the Hayes

Micromodem II and will presumably work with any communications program that is designed to work with the Hayes. Features include auto-answer and auto-dial capabilities with pulse or tone dialing. A communications program is supplied with the modem.

Ultimately, the CX series has two important things going for it. First, there is the lure of the multiple operating systems, and the vast potential that opens up in terms of choosing programs. According to Franklin, there are more than 10,000 software packages that will run on the CX under F-DOS, more than 5,000 packages that will run under CP/M, and another 10,000 that will run under MS-DOS. The total of 25,000 software packages to choose from is a staggering figure for a single machine. And even if you never make use of the machine's potential for expansion, it's nice to know that the flexibility is there if you need it. That assurance that it will continue to meet your changing needs is probably the most important feature that any machine can have.

Franklin Computer, CX-1 \$1,395; CX-2 \$1,695; CX-2C \$1,995; CX-2M \$2,295

IBM PERSONAL COMPUTER

Microcomputers were for electronics nuts, computer geeks, and eccentric millionaires. Until August of 1981. Then IBM introduced their Personal Computer and started a whole new ballgame. Today, every computer manufacturer must include microcomputers in their plans if they are going to be successful. This complete about-face in the multibillion-dollar computer industry will be written about in the future as an important turning point in the information processing business. Because so much of a person's life is touched by information and its many uses, the ramifications will probably be as far-reaching as the important inventions of recent centuries, including the telephone and the automobile.

The changes that are coming are based on two important trends that have taken place in the last few years, trends that are projected to continue for several more years.

First, manufacturing in the electronics industry is heavily automated. This means that economies of scale are at work to bring the price of manufacturing down as the volume of production increases. As more people and businesses buy computers, the cost of most of the components will come down, and as the costs come down, more people will buy computers. The cycle will continue until an equilibrium is reached where further economies are no longer available.

Second, the profits generated by electronics manufacturers are reinvested at significantly higher levels than most other industries. The invested dollars go into more research and new production facilities. This leads to better systems for less money, causing more people to realize the value of a computer. This trend will continue until the computer has become as common in the household as the television set.

The result of these two trends will be a world where information is available to people everywhere at a reasonable cost, making their lives more productive. In great measure, IBM is responsible for these advances. In the opinion of many market observers, the microcomputer marketplace was legitimized by IBM. Without IBM, the changes probably would have taken at least several more years to gain their current velocity.

International Business Machines, the premier computer manufacturer in the world, built larger and larger mainframe computers while the microcomputer market grew from its unnoticed birth in the mid-1970s. At first, IBM didn't take any notice of the little machines that were being produced in garages, and people thought that IBM would leave the micro market to small manufacturers and the Japanese consumer electronics companies. Then rumors began that included IBM's name and a secret project at an out-of-the way location in Florida.

In fact, IBM had decided to test the personal computer market, and did so in an uncharacteristic fashion—for IBM, that is. They put together a small group of employees and charged them with developing a personal computer, even going so far as allowing the staff almost unlimited freedom from normal corporate pressures. They were free to test new ideas, and implemented several of them, to the surprise of many. They developed a system that was "open," where the basic specifications were available for other manufacturers to review and copy, if they chose. They published the software specifications and bought software from outside vendors. They bought components from other manufacturers and built them into a complete system, using very few parts developed by IBM. All of these things were dramatic departures from IBM's traditional methods. And they worked. The wisdom of the decisions made by that small group of men and women led IBM to become the leading microcomputer manufacturer and made the IBM Personal Computer the de facto standard for the industry.

For many months after the PC's introduction, a controversy raged. Could IBM be successful in a marketplace so different from its traditional corpo-

rate niche? Was the PC a daring breakthrough or a poor imitation of the micros already available? Many observers challenged IBM because they hadn't made enough significant changes. These people looked at the INTEL 8088 microprocessor that IBM had chosen, and faulted it for its hybrid 8-bit/16-bit architecture. Others said that the IBM keyboard was so bad that no one should accept it. Still others saw the IBM PC introduction as a gigantic rip-off of the little, innovative computer manufacturers who had built the microcomputer market from scratch.

Now that several years have passed, the arguments have faded away, and the IBM Personal Computer is the leading microcomputer in the field, a machine that others must meet or beat in order to stay alive. It has become a catalyst for focused change, the kind of change that is most important for an industry to grow efficiently. In any area where there is rapid change, development will usually take place down many different paths initially. If no standard begins to appear, efficiency will eventually suffer because of duplication of effort. Although the IBM PC is a proprietary system, it has helped to provide some of the focus that will lead to more efficient development of microcomputers in the future.

In their configuration and pricing, IBM has followed a policy they developed long ago in the mainframe world: Keep the base price low, so you can claim low prices, but make virtually every feature, no matter how necessary, an extra-cost option, so you can really soak the unwary.

When you purchase a basic system unit, you get a keyboard, 64K (65,535 characters) of Random Access Memory (RAM), and 40K of Read Only Memory (ROM) that holds the machine's basic functions and the simplest version of BASIC. You can purchase an RF modulator and hook the PC to your TV set. But this system will do you little good, because you will have no external storage capacity, a critical element for any microcomputer.

To add storage capacity, you will want to add one or more disk drives. IBM offers a variety of these devices, ranging from a single-sided drive that will hold 160K up to a fixed disk drive that can handle over 10 million characters of information. In order to add the small floppy disk drives to the system, a 5¼-inch Diskette Drive Adapter is required. The adapter is a printed circuit board that will control up to four floppy-disk drives. The two most common configurations sold by IBM are the single 320K drive system and the double 320K drive system, both with 64K of RAM.

To add real storage capacity, you can purchase

the extended version of the PC, the PC XT. The XT system comes with 128K of RAM, one 360K diskette drive, and one 10 megabyte (10,240,000 characters) fixed disk drive. The PC XT also has an asynchronous communications adapter to allow your system to communicate through a modem and a telephone to other computers.

To give your computer a visual display equal to its own capabilities, you will want to add a computer monitor (display). If you choose to use a television set, you will be relying on a device designed for processing television signals. A computer display, on the other hand, has higher resolution, giving you much clearer text and high-quality graphics. While you can barely read 40 characters across a television screen, the monitor will allow you to see 80 characters quite easily.

In order to use an IBM display, you must also buy a display adapter. This printed circuit board will allow you to connect the monitor to your computer. IBM provides two types of adapters, one for text and one for both color and text. If you want to process only text, you will need the monochrome adapter and the monochrome monitor. This adapter also includes the circuitry necessary to run a printer.

To attach the IBM Color Display, you need the Color/Graphics Monitor Adapter. The adapter can run a color television set or almost any high quality-color monitor. If you also want to use a printer, this adapter does not include the required electronics as the monochrome adapter does, so you must purchase the Printer Adapter separately. The IBM PC is set up so you can use both a monochrome monitor and a color monitor. In fact, some software programs are designed so that both may be used at once, showing a spreadsheet on the monochrome display and a graph from the same spreadsheet on the color display.

A computer needs a printer to give you a hard copy of your work, and IBM offers several types. After buying the printer adapter (or the monochrome display/printer adapter described above), you can select either a dot matrix printer or a letter-quality printer. Dot matrix printers are faster and less expensive, but letter-quality printers produce higher-quality characters. Your IBM PC can run either type, or both, if necessary. In order to use a printer with the PC, you need to purchase a printer cable.

The IBM Graphics Printer is a dot matrix printer capable of speeds up to 80 characters per second, and reproduces text on sheets up to 10 inches wide. Other dot matrix printers available for IBM are the Epson MX100 and the Epson FX100. These

printers are both wide-carriage machines, handling paper up to 16 inches wide. The MX100 works at 80 characters per second, and the FX100 can move along at 160 cps.

The NEC Spinwriter model 3550 is a letter-quality printer. It works at speeds up to 33 characters per second. Because it is often used as a word processing printer, the NEC printer has an optional Cut Sheet Feeder to feed standard typewriter bond one sheet at a time, for an additional cost.

Internal memory is a critical area in the computer. It determines how large a program can be run and how much data can be stored for quick access (as opposed to diskette drive storage, which is accessed slowly by computer standards). The standard IBM PC comes with 64K of RAM, while the PC XT starts out at 128K. Both machines may be expanded to 640K of RAM (655,360 characters).

The system unit will hold up to 256K of memory. Once the system board is full, a memory expansion board must be purchased before more memory can be added to the computer. IBM offers the 64/256K Memory Expansion Option, a board that comes with 64K of additional memory. It has space for another 192K of memory chips. Once this board is full, the system will have 512K of usable memory. To expand to the full 640K, another expansion board must be purchased. In general, it is better to shop for memory boards from other manufacturers, as the available expansion slots in the PC or the XT are limited, and many manufacturers offer single boards that will allow the user to add up to 384K and include other functions as well.

Other options available for the PC include a Game Control Adapter, allowing the addition of joysticks for playing many popular games, an 8087 Math Co-Processor Chip to speed up the processing of mathematical programs, a variety of modems to allow your system to connect to other computers, and a cable to connect the modem to the asynchronous communications adapter.

The IBM PC is discounted at many IBM dealers. Some dealers discount at all times, while others, including the IBM Product Centers, have periodic sales. This discounting is the result of intense competition in the retail computer business. You should use it to your advantage.

Before you buy, shop around for your computer. The best way to do this is to configure the system carefully before you actually go to the computer store. Then shop the price for the exact same configuration at each of several stores. Because there are so many different possible configurations, use this review to list each option that you want and its

retail price. If the dealer wants to sell you a package that differs from your standard, spend a few minutes with your calculator and compare this price with the retail price. Shop for the largest discount in terms of percentage of retail price. If you buy from a store that is not an authorized IBM dealer, you may have problems with your warranty. Check this out carefully to protect yourself.

IBM maintains a staff of marketing representatives that specialize in quantity purchases. If you are contemplating the purchase of several machines, contact IBM for their special quantity discounts.

The PC uses an Intel 8088 microprocessor, one of the most popular computer chips available. When the first PCs rolled off the production line, the 8088 was a significant advance in micro technology. It was a chip designed with two things in mind. First, it was capable of addressing up to 2 megabytes of internal memory, 16 times more than its popular predecessors, the 8080 and the Z80. Second, it was designed to be upwardly compatible with the older chips. It provided a 16-bit architecture, but retained some features of the older 8-bit chips to make the migration easier. IBM even left a socket open in the system for adding an 8087 co-processor, a computer chip designed to speed up the processing of mathematical calculations in certain applications.

The first IBM Personal Computers available could only hold 64K (four sets of 16K memory chips) on the system board. The newer PC's now hold 256K (four sets of 64K chips) in the same amount of space. If you are buying a used computer, check to see if it is a newer model or an older one. The best way to tell is by looking for the cassette deck outlet in the back of the machine. When the newer machine was released in early 1983, IBM dropped the cassette capability. If the machine you are looking at has a cassette port next to the keyboard port, it is the older machine. The maximum memory available to the user on the older machine was 544K, limited by the internal switches. The new computers can hold up to 640K of user memory.

A fully configured IBM PC XT will have 640K of user memory from address locations 0 to 655,359. The 128K from locations 655,360 to 786,431 are reserved for the monochrome and color display storage areas. The following 32K, from 786,432 to 819,199, is reserved for expansion of the Read Only Memory (ROM), should other devices be developed that need internal software support. Locations 819,200 to 839,679 (20K) are used to support the fixed disk device(s). The next 164K, from 839,680 to 1,007,615 is again reserved for ROM expansion.

BASIC is stored in the 32K of ROM from 1,007,616 to 1,040,383. The final 8K, at the very top of memory, is the Basic Input/Output System (BIOS) stored in addresses 1,040,384 to 1,048,575. The total memory that can be addressed in the PC or PC XT is, therefore, 1,048,575 bytes (1024K x 1024).

In order to allow the addition of various features to the basic PC, there are expansion slots inside the system cabinet. The PC has five slots and the PC XT has eight slots. A normal configuration of the PC would use three slots, one for the Diskette Adapter, one for the Monochrome/Printer Adapter, and one for the Asynchronous Communications Adapter, leaving two slots for memory expansion, game control, clock/calendar boards, etc.

The PC XT comes with three boards already in place, the Asynchronous Communications Adapter, the Fixed Disk Drive Adapter, and the Diskette Adapter. You would normally use one more slot for the Monochrome/Printer Adapter, leaving four slots open for other functions. The XT, however, has two "short" slots and six regular slots. The Asynchronous Adapter uses one of the short slots, leaving you with three regular slots and one short slot. Several manufacturers have recently begun to manufacture boards to fit in the short slot, but there are many more boards available for the standard slots.

IBM's keyboard comes with 83 keys, including ten function keys that can be programmed to save typing. It has a separate keypad for entering numbers and controlling cursor movement. A "PRINT SCREEN" function will provide an exact copy of the screen on the printer at any time. Most of the keys are Typematic, able to repeat a character continuously while being held down. A 15-inch character buffer is included so even the fastest typist will not get ahead of the machine. Each key is designed to give audio feedback, clicking slightly so the user knows that the keystroke has been effective. The entire keyboard unit can be adjusted from 5 to 15 degrees for the comfort of the individual typist.

IBM's PC keyboard has been the subject of criticism from people who believe the IBM Selectric keyboard is the finest available. For some reason, IBM put several keys in different places from the typewriter keyboard, confusing experienced typists. They also put the cursor control keys on the numeric keypad, making it difficult to use programs that have both numeric input and cursor movement, such as most spreadsheet programs.

Instead of using the words "tab," "return," "backspace," and "shift," the PC keyboard features cryptic symbols for these functions. Most of these special function keys are the same size as the

standard letter keys, making them more difficult to use than necessary. This is especially annoying because the base of each key is much larger and could have been made big enough to use with ease. Finally, several of the keys are "toggle" keys, where pushing once turns the function on and pushing the second time turns that function off. Unfortunately, the user doesn't know which way the toggle is set. One manufacturer of add-on keyboards has solved this problem by putting a small light on each toggle key to tell the user its current status.

The disk drives offered by IBM fall into two categories, 5¼-inch floppy diskettes and 10-megabyte fixed disks. The least expensive option is a 160K floppy drive (180K with DOS 2.0 or higher), which records information on one side of the diskette. The next higher option is a 320K floppy drive (360K with DOS 2.0), a double-sided drive. The last option is a 10-megabyte Winchester Fixed Disk Drive. The drives can be configured in many ways, but the most popular configurations are two double-sided drives or one double-sided drive and one fixed disk drive.

If you are contemplating buying single-sided drive(s), a few months later you may be longing for double-sided drives. This can be costly, because you can't trade in the old drives for nearly what you paid for them. It is generally better to wait a little longer and start with double-sided drives, one at a time if necessary.

The maximum disk drive configuration supported by IBM has 10-megabyte drives and two 360K drives. However, DOS can support two additional floppy drives when the drives are placed in an external cabinet with their own power supply.

Two displays are available from IBM. The monochrome (green and white) monitor is excellent for text processing. It has very high resolution (720 x 350), can display 256 different characters, and displays 80 characters in each of 25 lines. The screen measures 11½ inches diagonally, and the 9 x 14 dot matrix characters have descenders, allowing the correct formation of letters like p and j.

The color monitor has a resolution of 320 X 200, a reasonable level, but not as good for text processing as the monochrome monitor. Several manufacturers offer PC-compatible color monitors with resolutions up to 640 x 480. Consider these optional monitors if you use both color and text modes regularly. The IBM color monitor can display up to 16 colors on a screen of 80 characters by 25 lines. The screen measures 12½ inches diagonally and uses an 8 x 8 dot matrix to form its letters.

The IBM Graphics Printer, made by Epson, most

closely resembles the Epson MX80 printer. It can handle paper up to 10 inches wide, operates at up to 80 characters per second, and can print up to 132 characters per line in the "compressed" mode. Three sets of characters are included, the standard English set, an international set, and a set with miscellaneous characters and symbols. Letters and characters are formed by a 9 x 9 dot matrix print head. In graphics mode, it is capable of 120 dots per inch horizontally and 216 dots per inch vertically.

Once someone has purchased a PC, they soon find themselves in the standard condition: They want to expand it. In addition to the normal options that can be added to the PC, IBM also offers two expansion units. One can be used with the PC and the other is designed for the XT.

These units each come with a fixed disk drive already installed. Each has eight expansion slots and a power supply capable of handling the additional requirements of the fixed disk drive, a second fixed disk drive, and eight adapters. Because of certain design restrictions, the expansion units can't accommodate memory cards, the primary monitor/display adapter, or a diskette drive adapter.

The PC expansion unit allows the addition of one or two fixed disk drives, making the PC similar to the XT. The XT expansion unit adds a second fixed drive. To add two fixed disk drives on either unit, both must be placed in the expansion unit. With the XT, this will enable the addition of another floppy disk drive in the XT cabinet.

A computer must have an operating system, and IBM has decided that the primary operating system will be PC DOS, written by Microsoft specifically for the PC. Other operating systems available for the PC include CP/M-86 and the UCSD p-System, but these operating systems do not support the XT's fixed disk drive, so they should be considered secondary to the DOS system.

DOS is available in three flavors, DOS 1.1, DOS 2.0, and DOS 2.1. Version 2.1 is only necessary when running programs on both the PCjr and the PC. The 2.0 version is mandatory for the XT, but has enough additional features that it should be chosen instead of the weaker DOS 1.1 in most cases. DOS 1.1 supports the basic PC, and has one big advantage over 2.0. Most of the DOS 1.1's programs are shorter than the 2.0 versions because extra programming is required to support the fixed disk drives. However, DOS 2.0 redeems itself by formatting floppy diskettes with more room (360K and 180K) than 1.1 does (320K and 160K), making up for the difference. If a PC has limited internal

memory, however, it will have a problem accommodating 2.0's larger programs in memory, so 1.1 should be used instead.

Applications programs, which do the bulk of the work visible to a computer user, are available for the PC family in overwhelming numbers. Probably the greatest benefit of owning a PC is all of the software available to make it run. If you like a particular program, it is probably available for the PC. Few other micro manufacturers can say that. It is the overriding reason that there are so many PC compatibles available on the market today.

There are two PC shortcomings that IBM should address. One is required right away, the other is on the wish list for the next year or two. First, the keyboard should be upgraded, or a second keyboard should be offered as an option. This would allow those people who must change back and forth between the PC and a typewriter to do so without traumatic adjustments each time.

The second need is the ability to access more than 640K of memory. Two years ago, this would have seemed an absurd request. After all, who could possibly use even 512K? But today, with the introduction of programs like Lotus *Symphony*, the extra memory would be quite useful.

Symphony requires at least 320K of user memory, and loading large spreadsheets or databases can actually run the PC out of memory. With older 8-bit, 64K machines, one way around the lack of internal memory was a technique called bank-switching. IBM should begin offering either a bank-switching option or a coprocessor board that can access over 1 megabyte of memory. Microprocessor chips that do this are currently available, and IBM could probably build a coprocessor board that would do the job.

The PC comes with excellent documentation, as expected from a company that spends a lot of time and effort providing quality customer service. Microcomputer documentation was quite shoddy before IBM entered the PC field. Today, because of their influence, most documentation is much better, and some is very good.

The PC comes with two disks full of sample programs and tutorials that teach the use of the machine and its various components. In addition to these introductory diskettes, the documentation includes a BASIC manual, a Guide to Operations, and, if you buy DOS, the DOS manual. The Guide to Operations also includes a diagnostics diskette which helps pinpoint problems when the machine won't run properly.

IBM has built a reputation based on service to its customers. The Personal Computer line is no ex-

ception. Although the 25-hour, on-site support familiar to mainframe users is an extra-cost option, several other options make more sense for most PC users. For the average user, either carry-in service, pickup and delivery service, or mail-in service will provide all the support that is generally needed.

To help find the part that needs servicing, IBM has included a full set of diagnostic programs to check out all of the PC components and tell the user what to do next. If the diagnostics indicate a problem, he can then take the machine to an authorized service center for repair. The PC comes with a three-month warranty, and the purchaser can buy a service contract for continuing service after the warranty expires.

Once you have a PC, there are literally hundreds of manufacturers of add-on equipment who will sell you things to make your system bigger and better. You can buy monitors, graphics adapters, memory boards, diskette drives and fixed disk drives, keyboards, data collection modules, coprocessors, serial and parallel ports, clock/calendars, and just about any other kind of electronic accessory imaginable. In addition, other companies will sell you dust covers, diskettes, keyboard templates, screen cleaners, printer ribbons, and longer cords to connect your monitor or keyboard to the system unit.

One accessory that solves a major PC problem is the Model 5151 add-on keyboard from Keytronic. The 5151 has separate cursor control keys, allowing the entry of numbers from the keypad and cursor control from the cursor pad at the same time. It also features lighted toggle switches, relieving the user of trying to remember which way the numeric and capital lock keys were last toggled.

International Business Machines Corporation, IBM PC, 64K, keyboard \$1,355; IBM PC, 64K, keyboard, 160K disk drive \$1,864; IBM PC, 64K, keyboard, 320K disk drive \$2,104; IBM PC, 64K, keyboard, two-320K drives \$2,633; IBM PC XT, 128K, keyboard, 360K, 10Mb \$4,995; Expansion Unit for PC, 10Mb \$3,390; Expansion Unit for XT, 10Mb \$2,695; Monochrome/Printer Adapter \$335; Color/Graphics Adapter \$244; Monochrome Display \$345; Color Display \$680; Sup'R'Mod RF Modulator \$70; 64K Memory Module Kit \$165; 64K/256K Memory Expansion Option \$350; Printer Adapter \$150; Printer Cable \$55; Graphics Printer \$595; NEC Spinwriter Printer model 3550 \$2,290; 5¼-inch Diskette Drive Adapter \$220; 5¼-inch 160K Diskette Drive \$289; 5¼-inch 320K Diskette Drive \$529; Fixed Disk Adapter Card \$695; 10Mb Fixed Disk Drive \$1,695;

Asynchronous Communications Adapter \$120; RS 232 cable for modem \$47; Intel 8087 Math Coprocessor \$260; Game Control Adapter \$55; DOS 1.1 and BASIC 1.1 \$40; DOS 2.0 and BASIC 2.0 \$60; DOS 2.1 \$65; CP/M-86 Operating System \$240 (also available from Digital Research for \$40)

LNW80 2

The latest LNW machine is a fine example of what can grow from small beginnings. LNW started as a manufacturer of expansion boards and kits for the old Radio Shack TRS-80 Model I. Then they built their own version of the Model I, which had a strong following among kit-builders. It was also available assembled and is still in production.

The LNW80 2, their latest introduction, is comparable to Radio Shack's TRS-80 Model 4 in capability, but the monitor and disk drives are separate units. Its size and shape are vaguely reminiscent of the Apple II but with a numerical keypad to the right of its typewriter-style keyboard. The 74 keys, including 12-key numeric pad, have a good feel for easy typing. Its metal case can support the weight of a 9- to 12-inch monitor and a matching pair of 5¼-inch floppy disk drives, so there is no need for a separate stand unless you want to move the computer often. Such a piecemeal computer does require a modest amount of wiring between the units and to the AC outlet; however, that is not all bad if you're tight on space or need some special arrangement of the components for your particular application.

Like the other machines with which it is compatible, the LNW80 2 uses a Z-80 microprocessor that runs at 4MHz, but you can slow it down to the old speed of the TRS-80 Model I at the flick of a switch. It comes with 96K of RAM available for general use and can be expanded to 160K. High-resolution graphics have another 17K set aside for its use.

It offers multiple levels of graphics resolution with a maximum of 480 X 192 pixels in either black and white or color. For the highest resolution graphics in color you must use an RGB monitor, which can be expensive. For lower levels of resolution you may use monitors with composite video inputs or regular televisions. Eight colors are available. The output on a monochrome monitor appears as eight levels of gray, so you can get some idea of color graphics content even without a color monitor. It will display up to 24 lines of 80 characters, but with some software—particularly Radio Shack's—you are limited to 16 lines of 64 characters.

For mass storage LNW offers a dual 5¼-inch single-sided floppy disk drive, but it will support up to

four 5¼-inch double-density, double sided drives, up to three standard 8-inch drives, and a 5¼-inch hard disk drive from its inboard controller. It also supports many types of printers and modems with its serial and parallel I/O ports.

Supplied with the computer is an extensive package of free software that includes general ledger, accounts receivable, accounts payable, payroll, *Electric Spreadsheet*, *Electric Pencil* word processor, *Microterm* modem program, *Chart-Ex* high-resolution business graphics charting program, CP/M 2.2, DOSPLUS, LNW BASIC, and *Microsoft BASIC*. It is also compatible with a wide range of programs intended for the TRS-80 Models I, II, and 4, plus the broad range of programs intended for CP/M and Cromemco machines. So even though LNW supplies only a few pieces of software, the LNW80 2 has an extensive library it may draw on.

Because of LNW's approach to design, the basic system can be expanded as needs arise, and you can tailor system size to your current needs. You don't have to confine yourself to the peripherals that they supply, as the LNW80 2 is easy to interface with a wide range of peripherals by other vendors. That is refreshing in a period when many manufacturers seem to be biasing their machines for compatibility with only the peripherals they sell or promote. On the other hand, LNW computers are handled by only a few dealers, and the computers must be returned to LNW for repairs at their California plant. Since it is metal-cased and has a cooling fan many of the common problems do not arise. Other touches that enhance its reliability are gold-plated edge connectors, and ICs in sockets. These last make it much easier for those with experience in electronics to do their own maintenance. With such a scarcity of dealers, you will find it easiest to look to LNW for information and support about the system.

LNW Computers, \$1,395; With 12-inch monitor and dual drive \$1,995

MORROW MICRO DECISION

Morrow computers have been around just about as long as there have been microcomputers. As a maker of boards, and later of the Decision I, a quality S-100 computer, they have won the respect of the serious hackers. In the last year or so, Morrow has tackled the market for desktop business systems, promising the quality, value, and innovation for which the company has long been known.

The two principal models in the Morrow small-business series are the Micro Decision 3 and Micro Decision 11. Basically the same machine, they differ primarily in the amount and type of disk storage

furnished with each. The MD-3 is built around two double-sided, double-density floppy disk drives; the MD-11 around a single floppy drive and an 11-megabyte hard disk. The two models are virtually identical in physical appearance, and at their hearts both feature 4 MHz Z-80 microprocessors running the CP/M operating system. The innards are built onto a single circuit board and cannot be expanded. Both computers use standard serial terminals instead of memory-mapped video.

These are well-built, utilitarian business machines. The MD-3 and MD-11 are relatively small—16.7 inches wide, by 5.3 inches high, and 11 inches deep, or somewhat smaller than an IBM PC. The MD-3 uses a pair of stacked floppy disk drives, with a formatted capacity of 384K each, for a total of 768K bytes of disk memory. The MD-11 comes with a single 384K floppy disk drive and 11 megabytes of hard disk memory. Both machines support what are called “virtual drives.” That is, any floppy disk can be reidentified so that the computer thinks more drives are connected than actually are. When a drive is redefined, disks are exchanged. Morrow’s drive mechanisms use the new quarter-turn door locks. These may seem unusual for those accustomed to the flip-down style locks, but they proved somehow easier to use and more positive.

In addition to reading and writing 5¼-inch diskettes created by or for any other Morrow computer, the MD-3 is compatible with Osborne (single density) and Xerox 820 disks. The MD-11 will read and write Osborne, Hewlett-Packard, IBM PC, TeleVideo, or Kaypro disks as well.

The speed of the Morrow drives proved really impressive. It took the MD-3 only a few short seconds to load *WordStar*, for example. But it was the speed of the single floppy drive in the MD-11 that proved absolutely astonishing—faster by far than any others in memory. And, as expected, the response of the 11-megabyte hard disk is virtually instantaneous. Programs seem to move from the disk to RAM memory in the blink of an eye. Morrow says that the maximum transfer rate from this disk is 625,000 bits per second. All 11 megabytes, by the way, can be used for storage; the disk has a total, unformatted capacity of 12.6 megabytes.

Internal memory in the MD-3 is the standard 64K bytes. The MD-11 comes with 128K. Each machine is equipped with the conventional set of input/output ports. Both come with two RS-232 parallel ports for printers, modems, and terminals and a Centronics-type parallel printer port. The MD-11 has one extra RS-232 port and a high-speed, synchronous RS-422 port, a fairly recent standard for terminal-to-mainframe communications. The RS-

422 port, however, requires additional software not yet available when this review was written.

Just about any standard video terminal can be used with the Morrow machines, although they come configured for “level three” terminals like the Lear-Siegler ADM-31 or the Wyse WY-100. After a long search, Morrow has finally settled on a Zenith Z-29 terminal, which Zenith is delivering with the Morrow nameplate. There was not enough time to give the Morrow/Zenith terminal an in-depth evaluation. Its keyboard, however, has a good feel, with full-sized, long-stroke keys, and the green-phosphor video display was clear and sharp. Just about the only objection was to the height of the keyboard base. It is a good deal thicker than it needs to be and a disappointment in a system otherwise so well thought out.

The Morrow terminals are an important part of the “matched set” concept of the MD-3 and MD-11—as are Morrow’s privately-labeled printers—but they are optional. This is the one nice thing about using a system designed around terminal communications rather than memory-mapped video: You can use whichever terminal’s video screen and keyboard you prefer. Terminals can operate with the MD-3 at up to 9,600 baud and up to 19.2K baud with the MD-11 by changing an on-board jumper. A set-up program adapts the system for use with various printers, modems, terminals, etc.

Following the lead of Osborne and Kaypro, the MD series computers are bundled with an impressive software package which includes a word processor, spelling checker, spreadsheet, database manager, business accounting system, two different BASICs, and the Pilot programming language. Also included are the CP/M operating system (CP/M 2.2 with the MD-3, version 3.0 with the MD-11), various utilities, and a user-friendly “shell” that makes using and learning CP/M very easy.

NewWord is the Morrow word processing software, and its commands are identical to *WordStar*, which the company had previously been furnishing. (Some models on dealers’ shelves may still be packed with *WordStar*.) If you can use *WordStar*, you can use *NewWord* almost immediately. If you haven’t yet had the “pleasure” of learning *WordStar*, you won’t be able to appreciate the superb documentation Morrow’s version comes with. The *NewWord* manual is actually readable! As a bonus, *NewWord* is file compatible with *WordStar* and offers at least one feature that is not standard with the latter program, merge printing—called *Mailmerge* in *WordStar*—for mailing lists and the like. *NewWord* also permits you to “undo” commands you may have made by mistake, such as erasing a

vital piece of text. In general, *NewWord* is a significant improvement over *WordStar*—easier to use, and for some operations a bit faster.

Manuscripts created with *NewWord* (or *WordStar*) can be corrected with *Correct-it*, the spelling checker packed with the computers. Designed by Aspen Software, authors of the *Random House Dictionary* spelling checkers, *Correct-it* comes with a dictionary of approximately 36,000 words, and supports auxiliary dictionaries of several thousand more. It is relatively fast, though short files seem to take almost as much time to check as long ones. Still, for a poor speller or typist, *Correct-it* is invaluable.

Morrow's database manager is *Personal Pearl*, a program that has been gaining a following among CP/M users for its power, flexibility, and simplicity. Even for beginners, it takes only minutes to set up a simple database, guided through the procedure by straightforward menus. Despite this ease of use, the program seems powerful enough for complex information management tasks, as well.

Quest is a series of bookkeeping programs aimed at small business users. The package consists of programs and report generators for tracking cash disbursements, sales and receipts, general ledger accounting, and financial reporting. Though the program disks are furnished with the computers, they cannot be practically used without sending the authors a one-time licensing fee of \$37.50 and receiving unlocking instructions. The programs will accept only a few dozen entries before this procedure is necessary.

The spreadsheet that Morrow originally shipped with its computers was *Logicalc* by Software Products International, a program of little distinction. A company spokesman says that *Logicalc* was the weak link in the Morrow systems and reports that it has been dropped in favor of the better known, more capable *SuperCalc*, by Sorcim. No copy was available for review, however.

The two versions of BASIC supplied are the industry-standard *Microsoft BASIC* and *BAZIC*, a Northstar-compatible BASIC authored by Micro Mike's. A considerable number of business programs have been written in Northstar Business BASIC, which differs slightly from Microsoft's. Another language, *Pilot*, is included, although it probably won't get used much. Known mainly as a teaching and classroom language, *Pilot* here is used to support Morrow's *Pilot CPMENU* and *Co-Pilot*, both menu-driven aids to using CP/M and the bundled software. Procedures for installing the

software and for rebuilding the files on the MD-11 hard disk are also written in *Pilot*. These are almost completely automatic and take the drudgery out of setting up.

Though more advanced users probably won't have much need for *CPMENU*, which appears on the MD-3, and *Co-Pilot*, the hard disk version, those new to computing will find them an enormous help. They turn the often unmanageable CP/M operating system into a series of menus for running software and utilities. The nicest part is that the CP/M instructions are not hidden, but appear on the screen after a menu selection is made. Watching the screen actually teaches CP/M by example. And, if you become tired of the menus, you can turn them off and still run CP/M in the conventional way.

The only thing lacking in the voluminous documentation included with the MD-3 and MD-11 is a comprehensive memory map. Otherwise, the computers come with excellent books covering all of the software, the CP/M operating system, and the computer, itself. Whoever writes Morrow's documentation has a rare sense of humor that makes reading a computer manual almost a pleasure. This anonymous author, in one section, likens computer hardware to Frankenstein's monster, and defines software as the "lightning bolt that jolts the monster to life, enabling it to run rampant over the innocent villagers of planet Earth."

In four months of working with them, no major problems have shown up on either of these Morrow systems. The only problem with either was a loose wiring harness to a disk drive on the MD-3. The computer could not identify this simply-remedied problem and kept reporting memory errors on power-up. This was a short-lived and minor glitch, however.

The two machines are almost completely software compatible, except when it comes to communications packages. The MD-11 has its disk controller where the MD-3 has its serial port, so terminal software must be patched before moving it between the two.

These small complaints notwithstanding, the Morrow computers both offer a lot to like. They can be recommended as professional tools for anyone with a small business to run. At these prices, the MD-3 and MD-11 are among the real values in desktop computing.

Morrow Computer Co., MD-3 terminal and software \$1,999; MD-11, terminal, 11-megabyte hard disk, and software \$2,999

SMALL BUSINESS COMPUTERS BETWEEN \$2,000 AND \$3,500

THE ACT APRICOT

Clearly ACT (Applied Computer Techniques) named its new computer unwisely. The name leads one immediately to the conclusion that here is yet another "fruity" Apple rip-off. What a shame, for the Apricot is among the most clever, inventive, cosmetically attractive, and easy-to-use computers to be found. It bears no resemblance whatever to apples and oranges. Its mass of features ensures that it will put a dent in the U.S. market.

The Apricot has the appearance of a well-designed microcomputer system. It consists of three components—the main processor unit, the keyboard, and the monitor. ACT calls it a transportable MS-DOS business system, and the package is physically small. The keyboard can be clipped under the main processor box to make up a single neat 16½-inch by 12-inch by 5-inch unit, about the size of a large attaché case. To make things even better, there is a flap that can be pulled down to cover the disk drive openings and a carrying handle that can be pulled out from the main processor box.

At \$3,100 the Apricot sports a true 16-bit 8086 processor, clocked at 5 MHz, and 256K of RAM, expandable to a whopping 786K RAM. It makes use of dual state-of-the-art Sony 3½-inch microfloppy drives, and it runs MS-DOS 2.0, CP/M-86, and Concurrent CP/M-86.

One look at the detached keyboard and you know you are onto something special. It has 96 fully programmable keys, laid out in the IBM Selectric style. It includes dedicated Help, Undo, Print, Menu, and Finish keys to make life easier, although every key on the keyboard can be easily redefined. The Caps, Lock, and Stop keys are LED illuminated to indicate their activation. There are a full numeric keypad and cursor movement keys. The angle of the keyboard is not adjustable, but seems to be set at an acceptable rake.

The feel of the keyboard is excellent. It has a tight full-travel action and no bounce whatsoever. It even appears to account for all tastes. There is no feeling of having "hit bottom" during a keypress, so angry typists can vent their frustrations without spraining fingers. At the same time, feather-touch typists will notice the keyboard response is fantastically swift. By the time the key has traveled a millimeter or so, the keypress has registered.

The microscreen deserves special mention. It is

located on the upper right of the keyboard and is a liquid crystal display of two lines of 40 characters each. There is a contrast control knob on the right of the keyboard to adjust for various LED viewing angles. Below the microscreen are six touch-sensitive function keys, each with a red LED to indicate when they are active. The microscreen is used for various system functions. It may be set under software control to echo the last three lines of the screen, allowing one to use the system without the monitor. A second and major use is to display system options while in the manager mode. You simply touch a key below a menu item to select a function.

Another feature of the microscreen is the calculator mode. Press the Calc key in the top row of permanently assigned function keys, and the LED becomes a full-blown calculator with memory. You may perform all the operations you desire, then return to whatever spot you were in before you entered the calculator. You can even send the results to the current program. As if this were not enough, the microscreen will also display the current date and time. Once entered, the date and time are maintained by a built-in calendar/time function powered by a 9-volt battery in the keyboard cabinet.

On the rear of the keyboard is a DB-9 jack, which will soon add mouse capability to the Apricot as well. With its LED-defined function keys the need for a mouse is questionable, but attention to detail is the name of the game for ACT.

The Sony microflopies supplied with the machine are single-sided only and afford 315K per disk. ACT promises dual-sided disk drives at an unspecified date. However, the present capacity compares favorably with the dual-sided 5¼-inch disk drives that are standard on most IBM PC-compatible computers.

These microflopies are far superior to the minis. The disk itself is protected by a hard plastic case and cannot be flexed. Further, the drives themselves are extremely quiet and operate at much faster access times than the typical 5¼-inch drive. To use a microdisk in the Apricot you merely push it into the drive slot—no doors, levers, or other gadgets to worry about. To eject a disk, you push the Eject button.

It is possible that microdiskettes might actually be a better medium for use on computers than their

5¼-inch counterparts. Why? The 3½-inch diskettes are not floppies. They come in rigid plastic cases that protect the disk surfaces until the diskette is loaded into the drive. Unlike floppies, you can throw them around without too much fear of having media problems caused by dust, grit, or fingerprints. Their small size makes them easier to store than floppies, and since they hold 315K bytes (on a single side), there is no loss of data storage capacity.

The computer inside the main case of the Apricot is built on a single board, maximizing reliability and ease of service when it is needed. Built around the 8086 microprocessor that runs at 5 MHz, it has a separate 8089 input/output processor to handle I/O operations to and from the drives and the asynchronous link. Room for an optional 8087 mathematics processor is also available on the board, although use of this add-on chip will require software specially written for it. The motherboard comes fully populated with 256K bytes of RAM. This RAM can be expanded to 768K bytes by adding a 512K RAM board to the system. Though the computer offers no color, it does offer sound via the TI74689 sound chip, which is the reason for the impressively large speaker. It is odd that the extensive version of MS-BASIC supplied by ACT does not include the sound features found in many other versions.

Perhaps the one drawback to the Apricot is that there are only two expansion slots. One will probably be taken in most cases by a modem card. This means that users who want to add more than just a RAM card will need a way to lead the remaining expansion slot to an expansion box. To do this, third party hardware manufacturers will have to come to the rescue.

The Apricot uses a monochrome high-resolution monitor capable of displaying 800 x 400 pixels, or picture elements, compared to 640 x 400 on the IBM PC. Although the display is only 9 inches measured diagonally, it provides crisp, clear, easy-to-read characters and very serviceable hi-resolution capability. This is further enhanced by the use of video interlace. The characters look as if they are etched on the screen. Hence, the small screen size suddenly seems irrelevant. Various shades of green are available for use by your software; for instance, the supplied *SuperCalc* uses helpful highlighted characters.

The custom CRT plugs only into the Apricot, from which it receives not only a video signal but its power supply. This makes cabling a breeze, but preempts the possibility of hookup to conventional, and less expensive, monitors. Extra Apricot CRTs cost about \$300 each.

The decision to supply the Apricot with three full operating systems is another good example of ACT's attention to detail and should not be overlooked when assessing the total cost of the system. The flexibility of the Apricot is unbeatable on this score. The user may choose CP/M-86, concurrent CP/M-86 or MS-DOS 2.0 to operate the machine. Each system has its own advantages and the ability to pick and choose among them allows the user to skirt the disadvantages of each.

Digital Research CP/M-86 is a fine operating system, proven over time and offering a vast array of software. Concurrent CP/M-86, also from Digital Research, enhances the versatility of plain old CP/M-86, and offers the capability of multitasking, wherein more than one program may be executed simultaneously.

Then there is MS-DOS 2.0, which offers some very provocative potentials. First, and very importantly, it is fully compatible with MS-DOS as it appears on the IBM-PC. By using the serial port and telecommunications drivers on each end, programs can be downloaded directly from the PC. Then using a supplied IBM Emulator program, they can be run on the Apricot.

There is much more than IBM compatibility when using the Apricot MS-DOS as an operating system. Foremost is the *Manager*, a beautifully designed user interface program that makes working with the Apricot easy for even the utter novice. If you so desire you need never face MS-DOS to use it, just use the *Manager* to get where you are going.

The Ladder is the name ACT gives the menu display, which appears on the screen as a grid of labels, including tools, SCALC, BASIC and so on. To make your choice you simply move the cursor to the appropriate box and hit the return key. Choosing Tools will put you into a subsystem that in turn offers a variety of options, each with its own subsystem. Let's say you want to modify the font that appears on your screen. You choose Tailor and then Font. Font puts you into *Font-edit*, an extremely easy-to-use program for creating one or more new characters, which can be saved and used whenever you wish.

Every one of the Manager's Tool subsystems includes Help, just in case you need a little prompting to change Fonts, Communications Protocols, Keyboard Definitions, Keyklik Loudness, Auto Repeat Speed, Port settings, and so on. The degree of control Apricot gives you over the machine at first appears overwhelming, but the Help screens and the fine configurator manual will get you through with a minimum of fuss. When everything is set up to your satisfaction, you have created a turnkey system that anyone can use.

In addition, the base price of the Apricot includes yet another bundle of software. You also get the 65X Graphics System from Digital Research, as well as two versions of BASIC (from *Microsoft* and Digital Research), *SuperCalc 1.5*, and *SuperPlanner* from SORCIM.

The documentation accompanying the Apricot is excellent. It consists of five manuals; an owner's handbook, with general instructions and an introduction to the Manager; a Configurator Guide, documenting the many utility programs available; a CP/M and Concurrent user's guide; an MS-DOS user's guide and a *SuperCalc/SuperPlanner* manual.

The Apricot is a well-designed, well-engineered microcomputer that will keep its users in the forefront of design philosophy for some time to come. It is a splendidly conceived and executed product that deserves the consideration of anyone looking for a solid, serious, do-just-about-anything business system.

Applied Computer Techniques (North America), \$3,100

APPLE III PLUS

The Apple III Plus is a computer whose time has come—and gone.

Just as this review was being written, Apple announced that while it would continue to manufacture the Apple III Plus, it would no longer be updating and improving the machine. The Apple III development team, a group of engineers and designers who had been assigned to keeping the III Plus up to date as computer technology advanced, was disbanded. Its members were shifted to other positions in the company. And that means that the Apple III has been abandoned and left to die, since constant improvement is all that can keep a product alive in the fast-moving computer industry.

The abandonment of the III Plus did not come as any great surprise, since the spot it formerly occupied in the Apple product line has now been taken over by two newer and more advanced Apples, the Macintosh and the Lisa. An Apple III Plus system now retails for around \$2,500 to \$7,000, depending on options and peripherals, and that makes it competitive with both the \$2,500 Macintosh and \$4,000–\$5,500 Lisa 2.

Even more important, the Apple III Plus no longer reflects its manufacturer's philosophy about the state and future of the computer industry. The Apple III was all business—a no-nonsense sort of a computer that a CPA would be proud to own. But it doesn't have the snazzy graphics, the windowing capabilities, the pull-down menus, or the electronic

mice that come with both the Lisa and the Macintosh. Its 8-bit 6502 microprocessor is as slow as molasses compared with the 32-bit Motorola MC6800 chip that is the brain of both the Lisa and the Mac. And in terms of looks—well, the III Plus is old, that's all. It's a pinstripe computer in an age of designer jeans.

Still, it's a pity that the Apple III Plus has been doomed to extinction—particularly at this precise point in its checkered career. Ironically, the Apple III has at long last fulfilled its promise; it has finally overcome every serious obstacle that ever kept it from becoming a tremendously successful product. Its bugs have been exterminated, it has been provided with a line of excellent software that it desperately needed, and it has even been made semicompatible with Apple II. But sadly for Apple III fans—and there are Apple III fans—all of these wonderful developments have come too late to save the Apple III.

To understand what happened, it's necessary to go all the way back to 1980, the year the Apple III was born. Unfortunately, the computer had a birth defect; it tended to overheat, and when its chips got hot they popped out. When the chips got part of the way out and started causing the computer to do funny things, some Apple III users discovered that they could reseal the protruding ICs by picking the computer up a few inches and then dropping it. But that wasn't very good for the rest of the computer—particularly its built-in disk drive—and it didn't do much to enhance Apple's reputation as a manufacturer of high-quality merchandise.

Another problem that plagued the III was its lack of software compatibility with the only other computer that Apple produced at the time, the phenomenally successful Apple II. The main reason that the III wasn't compatible with the II was that it was much more advanced. It could be purchased with either 96K or 128K of RAM, and its graphics capabilities were twice as good as those of the Apple II. If a way had been found back then to make the two machines compatible, the III might have become an enormous success. But that was not to be.

What happened instead was the Great Apple III Recall. Apple, as upset as its customers were over the pop-out chip problem, recalled every single computer that had the defect and replaced it with a brand new computer free of charge. Nothing like that had ever happened before in the computer industry, and nothing like that has happened since. But even the Great Recall failed to rescue the Apple III. With the pop-out chip problem solved, what the computer needed was software—lots of software. But software publishers weren't interested in a jinxed computer. They were interested in selling

software and making money, and you couldn't do that by writing programs for the Apple III.

Apple kept on trying to polish up the III, but to no avail. The price of the computer was lowered, and its memory capacity was increased to 256K. Neither move was very helpful. Then, in June 1984, the Apple III Plus was unveiled.

The III Plus didn't look all that different from its predecessor, the Apple III. But it did have some new features, including a new keyboard. The traditional numeric keypad was still there, but the rest of the keyboard was laid out like the keyboard of an Apple IIe—with the cursor keys arranged in a straight horizontal row to the right of the space bar, and with a programmable function key (an "open apple" key and a "closed apple" key) on each side of the space bar. The new computer also had a DELETE key, which the original Apple III lacked.

Other new features added to the Apple III Plus included:

- An "interlace" video mode that doubled the screen resolution of both text and graphics. When the computer is in its interlace mode, the monitor to which it is connected scans both normal lines and the spaces between those lines, and this gives the characters on the screen a solid look, instead of an appearance of being made up of dots or lines.
- A built-in electronic calendar and real-time clock that can automatically label disk files with the correct date and time.
- A redesigned main logic board and system hardware improvements aimed at upgrading the computer's reliability.
- A revised operating system, and new system utilities designed to support the improvements in the machine's hardware.

If these modifications don't look very major, it's because they aren't. Ironically, the most significant improvement that has been made in the Apple III over the past year is not the result of any changes in the Apple III, but the result of one very important improvement in the Apple II. This leap forward was the introduction of the ProDOS operating system for Apple II-series computers—the Apple II Plus, the Apple IIe, and the Apple IIc.

And why was the introduction of ProDOS so significant for Apple III users? Because, for the first time ever, Apple II-series computers are now partially compatible with the Apple III.

ProDOS is an advanced new disk-operating system that has replaced Apple DOS 3.3 as the standard DOS for all Apple II-series computers. Now, when you buy an Apple IIe or an Apple IIc, it comes with ProDOS. ProDOS was derived from a very sophisticated disk operating system called the So-

phisticated Operating System, or SOS. And SOS is the standard disk-operating system for the Apple III.

The introduction of ProDOS for Apple-II series computers does not make them completely compatible with the Apple III Plus or the Apple III. You can't just take an Apple III program and run it on a ProDOS-equipped Apple II, or vice versa. But when you create a file on an Apple II equipped with ProDOS, you can read that file on an Apple III—and when you create a file on an Apple III, you can read it on a ProDOS-equipped Apple II. What ProDOS does, in other words, is make Apple II-series and Apple III-series computers file-compatible. If you have a ProDOS-equipped Apple IIe at home, and an Apple III Plus at work, you can write a document or create a database file at home and print it out using your Apple III. If that capability had existed back in 1980, it might have saved the Apple III.

Another benefit of ProDOS is that it makes it easy for software developers to write programs for the Apple II and then modify them for the Apple III, or vice versa, because Apple IIs and IIIs now use such similar operating systems. Now that ProDOS is available for Apple II-series computers, companies like Quark and Haba Systems—that used to specialize in writing programs for the Apple III—are now turning out versions of their programs that will work on the Apple IIe and the Apple IIc.

Word Juggler, an excellent Apple III word processor created by Quark Engineering, is now available for the Apple IIe. So is *Catalyst*, a hard-disk file-management program that was originally developed for the Apple III. Another program that is now available for both Apple II-series computers is *III E-Z pieces*, an outstanding integrated software program developed by Haba Systems. *III E-Z pieces*, written originally for the Apple III, includes a word-processing program, a database-management program, and a spreadsheet program. Its Apple II-compatible version is called *AppleWorks* and is marketed by Apple.

A number of other good programs for the Apple III have also been written over the past year—and if they had existed in 1980, they might have also saved the Apple III. But they didn't, and that's that. Too bad. It had a hard life, but it was a pretty good computer.

Apple, Apple III \$2,995

COLUMBIA MPC-1600

The Columbia MPC-1600 is actually a family of very similar computers, all of which are like the IBM

PC up to a point. The 1600-1 and 1600-4 differ in that the -1 offers dual 320K floppy-disk drives and the -4 offers a single 320K disk drive plus a 12MB hard disk. The -1V and -4V offer, in addition to the mass storage, a CRT controller card with monochrome/color graphics. None come with a keyboard or a monitor and can be interfaced to a dumb terminal. The MPC-VP (1600-VP) is a portable version with two floppy-disk drives that has both a 9-inch green screen monitor builtin and an IBM compatible keyboard, but it is compact, transportable and has only one IBM-compatible expansion slot instead of the eight available on the other models. All come with a software package we'll get to later.

From across the room it is difficult to tell the nonportable version from an equivalent IBM system because they are so alike in styling and color. They will accept all IBM or IBM-compatible peripherals yet tested, and if IBM peripherals are attached, telling them apart is even more difficult. The only giveaway is the difference in the logo at the left side of the machine.

All of the Columbia models use an 8088 16-bit CPU running at 4.77 MHz and have a socket for an 8087 Arithmetic co-processing unit. Eprom memory of 12K and 128K of RAM is standard. The portable version may be expanded to 256K maximum and the others to 512K. In every way it is like the IBM PC. It is a true clone.

Since the nonportables are supplied without a keyboard you'll have to select one that has fewer of the traps that the IBM keyboard has for touch typists, e.g., having the Shift key one key further over than its normal position on a typewriter. When you budget for this computer remember to add an extra \$200-\$300 for a keyboard.

It's also supplied without a monitor and in the models without a V, without a CRT controller card as well. For monochrome applications most monitors are useable, but for the best color rendition a fine-pitch RGB monitor will make characters and graphics sharper. The alphanumeric format is 25 lines of 80 characters. The standard I/O configuration is one parallel port and two serial ports plus the IBM-compatible expansion slots which let you choose other cards with additional options including joysticks, light pens, and so on. You can use anything that can be attached to an IBM PC. There is no provision for sound synthesis.

The mass storage devices referred to earlier are half-height 320K double-density, double-sided floppy-disk drives and in the hard disk 12MB models the drive is also 5¼ inches. Other hard disk drives are also available. One of the attractive fea-

tures about the Columbia desktop models is that since they can operate with dumb terminals, and more than one serial ports are available, they can function as multiuser systems. Then their mass storage capability becomes really needed. However, this may be used in multitasking only if the operating system in use supports more than one user.

A computer is only as flexible as its software permits it to be, and these Columbia machines offer a wide choice of operating systems. In the package of supplied software (Super 3000 Software Pack) there are two operating systems, MS-DOS with RAM Disk and CP/M 86. Other software supplied includes BASICA with IBM PC-compatible color graphics, *Macro Assembler*, *Asynchronous Communications Support*, *Diagnostics* (troubleshooting guide), *Columbia MPC Tutorial Package*, *Home Accountant Plus*, *Perfect Writer* (word processing), *Perfect Speller* (spelling checker), *Perfect Calc* (electronic spreadsheet), *Perfect Filer* (data base manager), *Perfect Software Customer Support Hotline*, *Fast Graphs* (color graphics report generator), and *Space Commanders* (color graphics game). MP/M 86 is an optional multiuser operating system.

Even if that were the only software support available, the MPC-1600 would be an attractive computer system. However, the similarities between it and the IBM PC go deeper than mere looks or even compatibility of cards and peripherals. For all practical purposes, it will run all of the software available for the PC. That opens up one of the fastest-growing software libraries. Among your wisest investments would be GW BASIC for this computer. Many programs written for the IBM PC are in a version of BASIC that is compatible with GW BASIC. Columbia issued a list in November 1983 with over 500 programs that were written for the IBM PC/MS DOS and were compatible with the MPC-1600. Most of these had no restrictions noted. One or two had notes like "must change printer card" or "requires IBM printer card"; a few more could be used only with the dual disk drives or with the hard disk only, but the other notes were obvious ones like "color monitor required," "extra memory required," or "joystick required." Note though that the portable version does not require a printer card because that facility is built into the portable (VP) model.

Among the more interesting programs that are available for it are the Oasis-16 and XENIX operating systems. These plus the MP/M 86 all give these computers multitasking capabilities. But their memory should be expanded to its fullest and a

hard disk is necessary to fully exploit these operating modes.

Since these systems (except the portable) are supplied with only the basics, be prepared to spend more than the suggested retail price to get the system up and running. Many boards and options are available from Columbia but even greater capability may be obtained if you use boards available from IBM or the other suppliers that make boards and options for the IBM. As a rule of thumb, if it will work on the IBM it will work on the Columbia. But be careful in your selection. The computer world has had its share of misrepresentation. If you're in doubt about an aftermarket product ask Columbia Data Products or their dealer in your area.

Columbia's hardware and software support is limited but there is backup available through the Bell & Howell Service Company for hardware problems, and through Perfect Software for software. Other support is available through your dealer and as usual service contracts are a wise investment especially if yours is a business application.

Columbia Data Products, 1600-1 \$2,945; 1600-4 \$4,545; 1600-IV \$3,170; 1600-4V \$4,770; 1600-VP \$2,995

DEC RAINBOW 100, RAINBOW 100 +

Let's get this straight right at the beginning. The Rainbow is a good machine. Not perfect, but good. And that immediately makes it better than most of the competition.

In a world filled with plain vanilla Z-80 systems and lord-knows-how-many IBM clones, Digital Equipment Corporation has dared to put together an intelligently designed desktop system that not only does things differently from everyone else, but mostly does them better. Yet while doing them, it manages to remain compatible with most other major computers.

The first thing you are likely to notice about the Rainbow is its good looks. "Sleek" is a popular description. Like many computers, the Rainbow comes in three pieces: a keyboard unit, a monitor, and an undersized suitcase that holds the computer itself as well as disk drives and such. On most such systems, there is little point in having a detached keyboard and monitor. Salesmen are fond of putting the keyboard in their lap and mumbling the magic words "ergonomic design," but no one types that way. For serious work, the monitor goes on top of the computer, and the keyboard always seems to wind up on the desk, shoved right up under the monitor whenever possible. In short,

everything is just where it would be if the system came in one piece.

Not so with the Rainbow. If you want to set it up that way you can, but Digital has other ideas. The ads often show a desktop with the keyboard and screen only. Buy a Rainbow, and this is how your desk will probably look.

Digital's idea is really a pretty good one: Supply some fairly long cables, then put the main unit on the floor, either under the desk or to the side of it. This saves valuable desk space and makes it much easier to move the keyboard and screen out of the way when you're not using them. The computer itself, meanwhile, remains in easy reach, resting vertically in an optional stand, where it needs relatively little floor space. If you like to spread out when you work, with papers all over your desk, you'll find this arrangement gives you considerably more space to spread into.

If there's a flaw in the Rainbow's design, it is that on the outside, the Rainbow is virtually identical to two other Digital computer systems: the Professional 300, and the DECmate II. This is unfortunate at best, and may have been a major marketing blunder on Digital's part. It makes it extraordinarily easy to get these systems confused.

These are three entirely different systems, no matter how much they look alike. The Professional 300 Series and the DECmate II both have more in common with minicomputers than with other micros.

The computers in the Professional 300 Series are desktop versions of Digital's 16-bit, PDP-11 minicomputers. They use the PDP-11 instruction set, PDP-11 applications software and a choice of operating systems including POS (derived from Digital's RSX-11/M), and PRO/RT-11. (If you've ever heard of either of these before, you weren't discussing microcomputers.) The UCSD p-System is also available. Similarly, the DECmate II is a desktop version of Digital's 12-bit, PDP-8 minicomputers. It uses either of two operating systems: Digital's WPS-8 Word Processing System, or the COS-310 Commercial Operating System. The only concession that these two computers make to the rest of the microcomputer world is an optional Z-80 card that allows them to run CP/M programs as well.

The Rainbow fits much more comfortably into the microcomputer world. Inside the box is the familiar 8-bit Z-80 and the equally familiar 16-bit 8088. The system comes with two operating systems as standard—or three, depending on how you count them. CP/M-86/80 is an interesting combination of both 8-bit and 16-bit CP/M. When you load a

program, the system tests it to see which operating system it needs, then automatically goes into either CP/M or CP/M-86 as appropriate. MS-DOS on the Rainbow is absolutely standard except for the Editor, which has been adapted to use the Rainbow's function keys. The Rainbow will also run Concurrent CP/M and, somewhat more exotically, the UCSD p-system from Ticom.

Other details of the computer's innards include 64K RAM, a serial RS-232 printer port, and a serial RS-232 communications port, all standard. According to Digital, the Rainbow can be used with any RS-232 modem, and with any RS-232 printer that supports the X-On/X-Off protocol. Also standard is a dual disk drive that stores 400K per disk. There seems to be some confusion about this drive, with some people complaining that the Rainbow doesn't have dual drives and others complaining about its "limited disk capacity." Well, yes and no. Mostly no.

Granted, the Rainbow does not have two disk drives. What it has is better: a single drive that can deal with two disks at the same time. This is the exact functional equivalent of having two standard drives. And two 400K disks add up to 800K storage. This is more than most dual-drive machines have to begin with, and that's just the beginning. This one dual disk drive takes up only half the space of two single disk drives. You can add a second internal drive to give you a total of 1.6 MB of floppy-disk storage in the machine at one time. Or you can add an internal hard disk with either 5 or 10 MB of storage.

Other options on the Rainbow include memory expansion of up to 256K RAM, addition of a graphics board, and an Extended-Communications option that permits synchronous communications. Unfortunately, there are only three expansion slots available, which limits the number of options you can add.

The Rainbow 100+ is nearly identical to the 100, except that it comes with a 128K RAM as standard, and with a 10 MB hard disk in addition to the dual floppy drive. Also, the 100+ is expandable to 896K RAM rather than 256K, and only has two option-slots available. The third slot is already taken up by the electronics that go with the hard disk.

All this should give you some sense of the Rainbow's potential, but where you interact with the machine is at the level of the keyboard and monitor.

The monitor first. The only thing remotely typical about the Rainbow's monochrome monitor is its 12-inch diagonal screen. The monitor is small, reasonably light, and designed to take up a minimum

of space on your desk. It is also easy to adjust for comfortable viewing, thanks in large part to a built-in post that allows you to vary the angle of tilt. Another nice touch is the built-in handle. This is one of those details that doesn't matter much until you have to move the system from one desk to another; at that point it turns out to be helpful indeed.

Then there's the screen itself. To say that the resolution on the Rainbow's screen is impressive is to understate the case. It is good enough to let you switch from the normal 80-column width to a 132-column width, useful for spreadsheets and such, and still read the screen comfortably. Another major feature is the screen's ability to scroll smoothly, rather than in the jumpy, headache-producing increments you will find elsewhere. (It will also jump scroll if you prefer.) Of interest to word-smiths is that the screen can also display characters in boldface or underlined. It also has a "blink" and a reverse-video capability. Whether it will actually use any of these things is a function of your software.

On a more technical note, the Rainbow uses memory-mapped video, which means that when you make a change in whatever you are working on, that change is reflected on the screen essentially instantaneously. This is a small benefit for programmers, but writers who are easily distracted will find it a wonderful splint for their fragile attention span.

The monochrome monitor is even available in your choice of screen color: white, green or amber. This is a particularly nice touch considering that the "best" screen color is very much a matter of personal preference. According to DEC, you cannot use anyone else's monochrome monitor; considering the quality of the Rainbow's monitor, there's no reason why you should want to.

Possibly the only thing more impressive than Digital's monochrome monitor is their color monitor. Physically, it is a somewhat larger version of the monochrome monitor. It is about an inch higher and an inch wider than the monochrome version, providing a 13-inch screen instead of the monochrome's 12-inch screen. It is also about half again as deep, and about two-and-one-half times the weight. All this makes it about the size of most monochrome monitors.

There are two ways to be impressed by the color monitor. One is to use it for color graphics. The other is to use it for text. The color monitor has a special text mode in which it looks and acts for all the world like a green-screen monochrome monitor. The readability of the screen and the resolution of the characters are not up to the Rainbow's

monochrome monitor, but it is better than the monochrome screens on many systems, and certainly one of the best color monitors around. In fact, if the first time you see the Rainbow is with the color monitor in monochrome mode, you may not even realize you're looking at a color monitor.

When in text mode, the color monitor retains all the capabilities of the monochrome monitor, including the choice between 80-column width and 132-column width. Once again, the 132-column width is eminently readable. The color monitor also retains the memory-mapped video for essentially instantaneous screen update. Most important, there is none of the annoying flickering that shows up when rewriting the screen on the IBM PC, for example.

The color graphics are impressive as well. In high-resolution mode the Rainbow will display 800 by 240 pixels using four colors. At medium resolution it will give you 384 by 240 pixels using 16 colors. The 4 or 16 colors can be chosen from a palette of more than 4,000 colors on the Rainbow 100+. On the Rainbow 100, the choice is either from more than 1,000 colors or more than 4,000, depending on how your system is set up. These are just numbers. To get a sense of what they mean, you'll have to go to a computer store and watch the Rainbow color demonstration.

To use the color monitor you must have the graphics and color board in your system. You can also use the graphics board with a monochrome monitor, in which case you will have the same level of high- and medium-range graphics capabilities, but with 4 or 16 shades of gray, green, or amber.

The keyboard on the Rainbow just misses deserving the same high praise as the screen. At first glance it looks like one of the best-designed keyboards around. And indeed it is, in most ways. It looks nice, it feels nice, and you're not likely to notice anything at all wrong with it until you take a very close look, or better yet, try it. Then, if you're a touch typist, you will immediately realize that this is not a standard keyboard. This, by the way, is one reason why bosses should not buy equipment for their secretaries until after they ask whether their secretaries are willing to type on it.

A comment about keyboards seems called for here.

Given that the IBM PC has become the de facto standard for 16-bit systems, it almost inevitably invites comparison. Complaints about the IBM PC keyboard are legion. Among other things, the Shift-Lock key is on the wrong side, the Return key is further than a touch typist can comfortably reach, the Shift keys have been moved one space to the

sides, and many of the keys are mysteriously labeled with arrows that are not even slightly informative. All this brought to you by the same people who made the Selectric layout the standard for office typewriters.

Keyboards do present a real design problem. Computers need more keys than typewriters do. In particular, six additional characters must be squeezed in somehow—the tilde, backslash, left arrow, right arrow, vertical bar, and accent mark. Most keyboards stick the two arrows where the “upper case” period and comma would go on a Selectric. IBM chose to put the remaining four characters in with the rest of the character keys, and to move the Return key and Shift keys around somewhat. IBM then went on to create other problems in the keyboard.

Unhappily for touch typists, Digital chose to make some of these same mistakes—not all of them by any means, but two important ones. You'll find one extra key stuck between the Quote key and the Return key, another between the “Z” and the left Shift key.

On the bright side, these are the only two problems with the Digital keyboard. In all other respects, the typing keys use the standard Selectric layout. Also, unlike the IBM PC, which has all the keys crowded together in massive visual confusion, the Rainbow keyboard is divided into four distinct groups. Three of these run from left to right across the keyboard. They are the Typing keys, the Arrow keys, and the Number keys that form a numeric keypad. There is also a row of Function keys across the top, and a few specialized Function keys in the same grouping with the Arrow keys.

These groups of keys are separated from each other both visually and physically, a factor that partially redeems the keyboard. You'll find you can use your peripheral vision to help guide your typing when reaching for the Shift key or Return key. Also, the layout on the Rainbow does not present the same problems as it does on other systems. It is possible to get used to both placements in well under an hour of typing, even for people who still can't type accurately on other keyboards with similar layouts. The secret seems to be that the DEC keyboard is sculpted to minimize the extra reach needed for the Return key and left Shift key. This sculpting goes a long way toward solving the problem created by the layout—at least for those with big hands and long fingers.

If you can deal with the keyboard, you will find that the Rainbow has very little else to criticize. The operating systems in the standard package will run most generic CP/M, CP/M-86, and MS-DOS pro-

grams, assuming only that the programs are available in Rainbow format or that you can download them to your Rainbow. This makes the Rainbow compatible with thousands of applications programs. There are also hundreds of programs that have been modified specifically to make full use of the Rainbow's function keys. These include such popular programs as *Wordstar*, *Multiplan*, and *Lotus 1-2-3*.

The Rainbow can also read and write disks in IBM PC format, which means that you can exchange data between the Rainbow and the IBM PC (assuming the drives are in reasonably close alignment with each other).

Also noteworthy is the ease of setting up and using the Rainbow. In particular, there is the introductory program that comes with the system. The appropriately named *Learn Rainbow* is a teaching program that will introduce you to the basic capabilities of the hardware and operating system. You can go through this in about 90 minutes, after which you will be reasonably familiar with the computer.

A nice touch also is the Rainbow's built-in terminal-emulation mode. This effectively turns the Rainbow into a DEC VT-52 terminal. Among other things, this means you can get the system up and running as a dumb terminal simply by attaching a modem to the RS-232 port. This won't let you do anything very sophisticated in the way of communications, but it will give you a relatively simple route into many mainframe computers.

Finally, there is the Investment Protection Plan. Most computers come with a 90-day warranty, and it's up to you to bring the system back if there's a problem. Digital's Investment Protection Plan amounts to a one-year warranty with on-site service.

All told, the Rainbow has a lot more going for it than most other systems. If you're judging computers based on value, capabilities, and intelligence of design, this one belongs near the top of the list.

Digital Equipment Corporation, Rainbow 100, typical system with 64K RAM, operating system, monochrome monitor and keyboard, \$3495; Rainbow 100+, typical system with 128K RAM, 10 MB hard disk, operating system, monochrome monitor, and keyboard, \$6295; Color monitor \$950; Color-and-graphics board \$450; Extended-communications board \$500

EAGLE PC SERIES

With the introduction of the Eagle PC Plus and Spirit in late 1983, the company ended its practice

of bundling applications software with its major new products. This seemed a surprising departure, since Eagle's version of *Spellbinder* word processing was what made the 8-bit Eagle 2E series so successful. No less a class act was the 16-bit implementation, renamed *Eaglewriter*, which made its debut with the Eagle 1600 series and continued as a headliner when the Eagle PC was introduced in the spring of 1983.

What set apart the *Spellbinder/Eaglewriter* Eagles from almost every other manufacturer's computers (and now from Eagle's own Eagle PC Plus and Spirit) is that they were designed to run the word processing program as though they were dedicated word processors, yet not compromise their ability to run other applications. Central to this design was a keyboard with keys marked for word processing functions; when using other software they acted as ordinary keys. The keyboard implementation for 16-bit software, with 105 keys, made its debut with Eagle 1600; the same board was used on the first Eagle PC. Instead of the ten function keys the Eagle 105-key keyboard has 24. Most of them are placed on the uppermost row, above the number keys, where most good terminals have their function keys. This keyboard is available as an option for the Eagle PC Plus.

The introduction of the PC Plus line without applications software has made it easier to compare the Eagle product with the IBM PC. The Eagle PC Plus line contains three models: the PC Plus-1, PC Plus-2, and the PC Plus-XL. The differences between them are comparable to the differences among the IBM computers. The PC Plus-1 comes with one 320/360KB half-height floppy disk drive; the PC Plus-2 comes with two. The PC Plus-XL boasts a 10 MB hard disk drive and one floppy disk drive. All of the Eagle systems are based on the Intel 8088 microprocessor chip running at 4.77 MHz and include 128K RAM, keyboard, two serial ports, and one parallel port. Eagle also provides the MS-DOS and CP/M-86 operating systems and the *GWBASIC* interpreted BASIC programming language. The monitor and monitor adaptor board are sold separately.

The 84-key keyboard supplied with the PC Plus is virtually identical to IBM's, but it boasts a large and well-placed RETURN key. The BACKSPACE and the left-hand SHIFT key are located where touch typists expect them to be, a great convenience when compared with IBM's keyboard. Red LEDs on the NUM LOCK and CAPS LOCK keys light up when they are shifted, and the calculator pad cum cursor keys are contiguous with the rest of the keyboard.

Unlike IBM, Eagle uses half-height floppy and

hard disk drives; additional drives must be attached externally. A clever feature of the Eagle cabinet is an alcove beneath the chassis containing the drives and other innards. The keyboard fits perfectly in the space when not in use, along with the cable which is routed through an opening at the rear of the alcove and thence to its receptacle.

Adding new memory chips to the mother board is no mean feat. The keyboard alcove must be removed. Too many screws later, a large metal plate with the disk drives still attached must be lifted off after carefully disconnecting a variety of cables. The memory can be expanded to 256K by populating the 16 unfilled chip sockets with 8K-byte (64K-bit) memory chips. The same sockets will accept the new, pricey 64K-byte (256-Kbit) chips, thus increasing the capacity to 640K. (The memory of the discontinued Eagle PC could be expanded to 512K on the mother board, using 8K-byte chips.)

Adding expansion boards to the Eagle PC Plus is a far less onerous task than adding memory. The expansion bus is reached through means of a plate held by seven screws—compared with the 17 that must be removed to get at the memory chips. In fact, it is easier to swap boards on the Eagle PC Plus than on the IBM. The PC Plus has a four-slot expansion bus, compared with three on the earlier PC. One of the slots is occupied by the floppy disk controller, and another must be used for whichever monitor adaptor board the buyer chooses. That leaves two open slots remaining on the PC Plus-1 or -2. The PC Plus-XL contains, in addition, a hard disk controller board, so it has but one open slot. The number of open slots should not be a limitation, however, since the common uses of expansion slots are already provided on the Eagle mother board: memory expansion, two serial ports, and one parallel port.

The optional video adapter boards from Eagle interface well with standard monitors. Both provide 80 columns by 25 lines of text. In addition, the medium-resolution color board supports 640 x 200-pixel displays with up to 16 colors. More sophisticated color boards are available from other manufacturers, but no matter how fancily a color board performs, the bottom line for readability is good resolution. This is especially important for word processing. So, the Eagle color board gets high marks for medium-resolution performance with any decent monitor that matches its specifications. This is no less and no more than the buyer pays for; really good high-resolution color is still costly.

Prolonged and concentrated work with a medium-resolution color screen is hard on the eyes. Unless color is truly important for routine applica-

tions, it would be better to use the Eagle's standard monochrome adapter card. Better still is the 720 by 352-pixel monochrome display board, which can also has graphics capability. A good, high-resolution monochrome monitor such as Eagle's 12-inch model should be used. Despite a slight shimmery effect in the scrolling due to the high-persistence phosphor, the clarity is superior.

While the inclusion of two serial RS-232 and one parallel port on the PC Plus mother board is a welcome extra, adherence to IBM's "standard" for the cable connectors lends further confusion to the already chaotic business of providing proper cables for printers, modems, and other peripherals. The sockets for the serial ports located at the rear of the cabinet are 25-pin male DB-25s. IBM had been virtually the only manufacturer to use such sockets; now Eagle has changed over from female sockets on the original Eagle PC.

Worse still has been IBM's use of a 25-pin female DB-25 connector for its parallel printer port. It had been an unwritten rule that parallel printers and other devices should be hooked up to computers with Centronics 36-wire connectors. IBM uses the DB-25 connector for both serial and parallel devices, a practice that has misled the unwary. Unfortunately Eagle changed over from Centronics to DB-25 when it released the PC Plus.

The issue of compatibility must arise when discussing any computer that emulates the IBM PC. The Eagle PC Plus does not run the IBM PC demonstration disk, nor does it run the Digital Research *Concurrent CP/M-86* demonstration disk. These are by no stretch of the imagination the sort of programs any but hardware reviewers would test. Any program that makes calls on the IBM hardware rather than on the operating system will more than likely fail to work on non-IBM machines. The Eagle PC-Plus runs both the IBM version of *Lotus 1-2-3* and the Microsoft *Flight Simulator*. They are considered acid tests of IBM compatibility.

The PC Plus processes data somewhat faster than the IBM PC. Reformatting of *WordStar* screens is noticeably faster on the PC-Plus. It took IBM PC 45 minutes to sort on last name a 179K *dBASE II* mailing label file containing 1,000 names and addresses; it took 40 minutes for a PC-Plus. The speed of such sorts depends mainly on the speed of writing and reading data to and from a disk drive. When performed with an IBM PC with an aftermarket hard disk, the sort took 16 minutes, compared with 13 minutes and 40 seconds for PC Plus-XL, Eagle's hard-disk model.

The difference in speed is mainly due to the

IBM's use of parity checking, which adds an extra bit to every byte processed and accounts for an approximate 15 percent reduction in speed. Most experts agree that such checking is unnecessary with today's microchip memories. The extra parity bit used in the IBM PC also requires nine rather than eight 8K-byte memory chips per 64K of memory expansion.

Each time it is booted up, the IBM PC performs a series of memory checks. This explains why it takes so long to boot—up to a minute with a fully populated machine. The PC Plus does not automatically run a memory test upon booting. However, if the T key is depressed when turning on the power, the PC Plus will perform a series of memory tests.

As hinted earlier, a hard disk improves data processing speed even while it provides lots of online storage. The 10 MB hard disk in the PC Plus-XL makes a world of difference in speed and convenience. When the XL is turned on, the machine first tries to read the operating system from the floppy drive. If an operating system is not found, the system is then read from the hard disk. In order to protect the hard disk and the read/write heads when shutting down the machine, Eagle provides a utility for parking the heads safely. The command PD—which could stand for either “Power Down” or “Park Disk”—results in an onscreen message either to remove the floppy disk and shut off the power or press ESCAPE to continue processing in case you've changed your mind. This is needed protection against possible damage to both the heads and the disk itself, but it is seldom provided.

As a hardware package with numerous options, Eagle has come up with a strong competitor in the IBM PC world. While it is disappointing that the company chose to abandon its blend of complementary hardware and word processing software, the new product is more than a mere imitation of the IBM PC. Designing a new computer, like designing a new automobile or any other highly engineered product involves making compromises between what is desirable and what can be offered at a given price. Seen in that light, Eagle's compromises are better than most. It may be argued, in fact, that the company has made wiser compromises than the company whose computer it has emulated.

Eagle Computer, PC Plus-1 \$2,195; PC Plus-2 \$2,495; PC Plus-XL \$4,295; Standard monochrome board \$295; High-resolution monochrome board \$495; Color monitor board \$295; Monochrome monitor \$329; 105-key keyboard \$295; 84-key keyboard \$195

EPSON QX-10

After Epson made its name in printers, it could be only a matter of time before they introduced a computer. And it was easy to predict what the computer would be: a CP/M machine, with a Z-80 processor, two disk drives, and 64K of RAM. In short, it would be like their printers—sturdy, unassuming, and about half the price of the existing competition.

It did not quite work out that way. The QX-10's hardware is relatively standard—at least until you look at the details—but it comes with some of the most innovative software on the market. Even before *Lotus 1-2-3* appeared, Epson committed themselves to the idea of integrated software, then designed their computer around it. The result, *Valdocs*, combines the machine's operating system and several applications programs into a single, easy-to-use package. It has become one of the current standards for user friendliness.

Backed by an aggressive marketing campaign, the QX-10 has become the third-largest selling computer in the United States—this in little more than a year, and without the IBM compatibility that all save Apple have found essential to success. *Valdocs* gets much of the credit for this. And yet, some respected industry analysts question whether this computer delivers all that its makers claim.

One thing no one is likely to deny is that this is a beautiful system. It comes in three pieces: a 12-inch monitor, a sleek box containing the electronics and disk drives, and a detached keyboard. In off-white with charcoal accents, it may well be the most polished piece of product design in the small-computer industry.

The monitor is a green-screen model. Driven by 32K to 128K of dedicated video memory, it displays graphics with resolution up to 640 by 400 pixels. The phosphor fades a bit slowly, creating ghosts whenever the screen image changes. The effect is not as persistent or bothersome as with a few monitors, but it must be consciously ignored. The front of the screen is etched to cut glare, but the only way to shift the viewing angle is to prop the monitor with a book.

The system unit is broader than some, 20 inches wide by 13.6 deep, but it's barely more than 4 inches high. The overall effect is almost startlingly trim. Inside is a fairly standard 8-bit computer—but with some novelties.

The system's brain is a Z-80A microprocessor running at a clock speed of 4 MHz. Its major hardware advantage over other 8-bit computers is its memory. Though limited to the standard 64K of RAM when used with CP/M, it addresses up to 256K

of working memory when running under *Valdocs*. This makes it a serious contender for computing jobs that ordinarily require a 16-bit processor; their primary benefit is seldom computing speed—a well-programmed Z-80 can often outdistance an 8088 performing the same task—it's simply that they can manipulate more than 64K of program and data at a time. The QX-10 manages to duplicate this feat quite adequately.

Also mounted in the system unit are two disk drives merely 1.5 inches high. These drives are among the quietest and fastest available. Where others use a stepper motor to position the read/write head, these use a voice coil like those of hard disk drives. The result is extremely quick movement from track to track and near-silent operation.

With most drives, inserting a disk is a two-step operation: First you put the disk in, then you close a door or turn a latch. With the Epson drives, you simply insert the disk, and it clicks into place, much like the new microfloppy disk drives. Unlike most systems, however, the Epson does not recognize when the disk has been inserted, even on booting up. You have to press a small button on the front of the drive to notify it that it is time to read the disk. The *Valdocs* system expects to find a data disk in the righthand drive and displays a reminder when it is forgotten.

Where the differences between this computer and others become obvious, however, is in the keyboard. Two models are available, one in the standard ASCII layout for use solely with CP/M software, the other specially adapted for use with *Valdocs*. This so-called HASCI arrangement—for "Human Application Standard Computer Interface"—puts the normal typewriter keys in the Selectric layout and includes several groups of special-purpose keys. The cursor control keys are grouped with several editing keys to the right of the typing area. At the far right is a full calculator-style numeric pad, with a separate ENTER key, the four standard arithmetical functions, and even a decimal tab key. Missing are the ESCape and BREAK keys required for many non-Epson programs.

The unique keys are arranged in four groups across the top of the keyboard. There are four marked "system controls," five file-control keys, four for applications, and four grouped over the legend, "typesyles." These are the keys that make *Valdocs* work; for CP/M programs, they have no set function.

The system controls are all general-purpose functions that either are unavailable on other systems or are made easier by assigning them to a single keypress. A STOP button halts *Valdocs* and

its built-in applications in mid-operation so that you can take stock of what is happening or abort the function. The HELP key calls on a disk file full of instructions. Press it, and you receive a menu of topics on which assistance is available; the list varies with your position within the program. The UNDO key reverses your last command—just the thing for the times when you erase a few words too many. And COPY DISK reduces the backup procedure to a one-key function.

The five file-control keys handle all the usual disk operations, and then some. STORE and RETRIEVE move files to and from a disk, while PRINT and MAIL route them to the printer or an electronic communications network. The real novelty is INDEX: This takes the place of the DIR commands in CP/M and MS-DOS. But instead of using only a file name and type, each file stored to disk may be described by up to 16 key words. Like a small, special-purpose database manager, INDEX can call up files according to key words linked by boolean logic functions—AND, OR, or NOT. While this takes a little extra time, it makes it easy to manage complex libraries of files without resorting to MS-DOS 2.0-style paths and path names.

The crucial cluster of keys is the application group. *Valdocs* comes up in its built-in word processor when you turn the system on. The applications keys quickly switch you over to a four-function calculator, scheduling, or graphics, or to a menu of miscellaneous functions.

The *Valdocs* word processor is closer to the ideal of "what you see is what you get" than almost any other. Using bit-mapped graphics, the QX-10 displays text in boldface, italics, underlined characters, or a combination, with on-screen spacings of up to three lines apart. It is these functions that the "typstyle" keys control: Simply hit the appropriate keys to begin, say, boldface italics, and repeat to stop. More typefaces and type sizes are slated for eventual addition.

All the standard word-processing functions are available in *Valdocs*, and some less common ones as well. Text may be justified, reformatted, moved in blocks, or searched for embedded strings. A built-in print spooler lets you print out up to three files automatically while writing a fourth.

By the time this book appears, *Valdocs* should be in its second full revision, now long delayed. If previous updates are any indication, it should be considerably more convenient. As a result of earlier changes, the word processor now "wakes up" in replacement mode, though early versions began with insert mode. Another change lets you avoid an irritating idiosyncrasy: *Valdocs* usually holds its

cursor in the middle of the screen while the text scrolls past it. This "feature" can now be turned off, allowing the cursor to move normally through stationary text.

A third update is tentatively scheduled for the beginning of 1985. Among planned additions are a builtin sorting utility and full spreadsheet and database applications.

The most frequent complaint about *Valdocs*—that it is slow, at times painfully slow—stems from its graphics-oriented display. With early versions of *Valdocs*, a good typist could easily get far ahead of the display, and it's distracting to watch words you entered long ago appear on screen as you type fresher ideas. This is not quite the problem it once was; later revisions run faster, and it is now possible to turn off the graphics display and switch to a still-speedier character-oriented mode—losing the on-screen boldface, italics, and underlines in the process. However, quick typists will still find this program an exercise in patience.

The most complete discussion of *Valdocs*'s flaws has appeared in *Byte* magazine, in Jerry Pournelle's "User's Column." The debate over its merits culminated in a reasonably full critique by Pournelle and a matching defense by Chris Rutkowski, of Rising Star Industries, the program's designer. The exchange appeared in *Byte*'s August 1983 issue, and addenda have appeared almost monthly since then. Anyone considering the QX-10 would do well to read before buying.

Make sure, also, to give the machine and its software a thorough workout in the store. As a CP/M computer, the QX-10 is among the best; complaints about its hardware have been very few. But you will still wind up paying for *Valdocs*, and you may decide that it makes more sense to settle for a less costly computer and use the saving to buy software of your own choosing.

Epson America, \$2,995

LEADING EDGE PERSONAL COMPUTER

A strange thing has happened in the personal computer industry. Ever since IBM decided to get into the personal-sized computer business a few years ago, most of the software being developed has been written to be run under the operating system that Big Blue chose for its machine, MS-DOS.

This factor, along with an occasional shortage of IBM PCs, has helped to create a new class of personal computer, the "IBM PC-compatible" system. These compatibles can often run much, if not most, of the software written for the IBM and are being

marketed as an alternative to it. PC-compatibles are pushed on basis of several features. Some are sold as being less expensive than comparable equipment from IBM. Others are sold because they include free software, portability, and text/graphics capability on the same screen. All purport to give something that IBM doesn't.

The Leading Edge PC is a fairly recent entry into the PC-compatible line up. Both this system and Sperry's PC are made by Mitsubishi, and they are almost identical mechanically and electronically. They do differ in the keyboard, monitor, and software included with the system, as well as in the price.

Physically, the computer is housed in a box a bit smaller than the IBM. It contains two half-height disk drives, 128K of RAM, and parallel and serial I/O ports. The disk drives are double-sided, with a capacity of 320K each under MS-DOS 1.25, the version of the operating system included with the machine. MS-DOS 2.1 seems to work with the machine, though the company does not support it. This version of MS-DOS can store 360K per drive. The Leading Edge PC has seven expansion slots, although only five are actually usable. The other two are taken up by the monochrome monitor/parallel printer card and the floppy disk-drive controller, both of which come with the system.

Standard equipment also includes a green-screen monitor, and an 83-key IBM format keyboard. The keyboard, while it has a good feel, unfortunately does not have LEDs on the NUM LOCK or CAPS LOCK keys. Many other compatibles have taken the opportunity to correct this deficiency. Most people who have used both kinds of keyboards—those with and without LEDs—prefer those which give you some idea of what mode you are in. This is not a big deal, but when you go up against Big Blue, you need every ace you can get. The keyboard plugs into the front of the system, which gives you a bit more latitude on placing it, but makes it almost impossible to locate the keyboard directly in front of the system unit.

In addition to the hardware, the Leading Edge PC comes with four binders of documentation and software. Software included with the computer consists of the MS-DOS operating system (version 1.25), Microsoft's *GWBasic*, and the *Leading Edge Word Processor*. While this is not as much software as some other compatibles offer with their systems, it is certainly adequate to get you started, and is more than IBM gives you. The documentation, contained in the now-familiar small, slip-cased binders, consists of one volume each for the operating system, BASIC, and the word processor, and

an additional binder that combines an "Operator's Guide" and the "Technical Reference Manual." The MS-DOS and BASIC manuals are Microsoft's, with some modifications by Leading Edge. While usable, they are not especially well done. The Operator's Guide/Technical Manual and LE Word Processor Manual are another story. Both are attractive, well organized, and easy to use.

The Operator's Guide takes you through the set-up and check out of the system, and covers the use of the diagnostic disk, should it be necessary for you to use it. It is followed by a comprehensive Technical Manual, which gives you extensive data on the hardware. IBM charges you extra for this technical reference, and it was nice of Leading Edge to throw it in.

The Leading Edge PC has some hardware similarities, and some differences from the IBM. It shares the same processor as the IBM, the 8088. Like the IBM, the LEPC also has a motherboard socket for the 8087 numeric coprocessor chip. Unlike the IBM, the LEPC's processor can run at either of two speeds. The normal clock speed for the processor is 4.77 MHz, about the same as IBM's, but unlike the IBM, it can be set at a higher speed of 7.16 MHz. Not all software runs correctly at this speed, as some software depends on internal timing routines set for the normal IBM clock speed. As this speed adjustment is accomplished by setting a switch on the motherboard, you may not want to play around with it and leave it set on normal. If you do a lot of number crunching, you will probably get a nice benefit between the 8087 and the increased clock speed.

Leading Edge claims compatibility with "... the complete range of IBM and IBM compatible hardware and software." As Leading Edge did not supply the color graphics adapter for testing, it was not possible to confirm this claim. Several popular packages were tested on the LEPC, including *WordStar*, *Personal Pearl*, and *FORMULA II*. All worked with no problems and even seemed to run a bit faster on the Leading Edge machine than on the IBM.

There were several minor flaws in the hardware and software. The first of these concerns the monitor. The linearity was slightly off on the monitor received; the characters on the top of the screen were larger than those on the bottom. While the vertical height adjustment helped a bit, the monitor does not include a linearity adjustment on the outside of the case, nor does the documentation detail how to make this sort of adjustment. This is a minor detail, but a distraction after several hours of looking at the screen. Another distraction is the high

persistence phosphor used on the monitor. IBM's monochrome monitor also uses this type of phosphor, and the ghosting is distracting on this monitor as well.

Then there is the built-in clock/calendar. This feature is part of the system and even has provision for battery backup. Unfortunately, Leading Edge substantially diminishes its usefulness by not patching MS-DOS to read the clock/calendar automatically on booting. It seems a bit pointless to have an internal clock/calendar if DOS ignores it and asks you for the time and date.

A system such as the Leading Edge PC must be judged against three criteria. The first judgement is how it stacks up against the IBM. Next it must be compared to other PC-compatibles. Finally, the computer should be evaluated on its own.

Compared with the IBM PC, the LEPC comes out pretty well. It costs a bit less, has more expansion slots, comes with more software, comes with twice as much RAM as a standard feature, and can run a substantial amount of software written for the IBM. Comparison with other compatibles is not quite as easy. From a hardware point of view, the Leading Edge PC seems to be as well constructed as any compatible. It does suffer a bit, however, in comparison with those machines, such as the Compaq, Columbia, and Corona, which have both text and graphics capability built in. Additionally, some other systems, such as the Columbia, come bundled with considerably more software. If you have need for those applications, as well as word processing, this will have to sway your choice of a computer.

Last is how the Leading Edge Personal Computer stands on its own. It does this exceedingly well. It is a well made, reasonably priced computing system. The LEPC is a complete computer; it provides an adequate amount of memory, two disk drives, a monitor and keyboard, several I/O ports, and software. To get started, all you must add is a printer. All in all, the Leading Edge PC is definitely worth your consideration.

Leading Edge Products, PC System, including 128K system unit, two 320K floppy disk drives, monochrome monitor, keyboard, MS-DOS 1.25, *GWBasic*, and Leading Edge word processor \$2,895; 128K RAM card \$395

MACINTOSH

In a bold departure from conventional small-computer technology, Apple's new Macintosh is a powerful personal computer for noncomputerists.

At \$2,495 without printer, second drive, software, or modem, the Macintosh is clearly directed to businesses rather than to the public. In this sense, it is designed to compete with IBM's PC and less costly compatibles. Nonetheless, many will wind up in the homes of writers, teachers, and software developers, many of whom can get a nice price break as pioneer buyers. It will appeal to almost anyone who wants a computer that offers nearly effortless operation.

Any new user can operate the machine without memorizing software commands, innumerable keyboard codes, or even working with a computer language. To underscore this point, the Mac doesn't even come with BASIC, the omnipresent high-level computer language that traditionally accompanies other personal computers.

Instead, the Macintosh displays icons, small pictures on the video screen that represent your possible actions, much as rest rooms are often represented by a drawing rather than words. No understanding of a language is needed in either case. The computer operator tells the computer what to do by moving a pointer on screen to the icon for the chosen activity and simply pressing a button to make it all happen. The pointer is controlled by moving a "mouse," a cigarette pack-size controller, around the desktop beside the computer. This requires a 6-inch to 8-inch square of free space to maneuver the device.

The Mac has more to distinguish it from other personal computers than its mouse and the elegant supporting software pull-down menus, and "windows." It's truly a different breed, from its outward appearance to its electronic guts. For example, the main unit, which incorporates the machine's video monitor and a disk drive, measures only 13½ inches high by 9¾ inches wide by 9¾ inches deep, taking up only a tad more space than, say, a standard-size magazine on a desk. Its detached keyboard, with full-size sculptured keys, 58 of them, is not a space-eater either. Compact size was achieved here by eliminating a numerical keypad, which is available as an external option, and all function keys.

The main unit contains a 9-inch diagonal black-and-white monitor, one Sony 3½-inch disk drive, 128K of RAM, 64K of ROM, two serial ports, and a four-channel sound port. Together with the keyboard, the system weighs less than 23 pounds. It's luggable, therefore, though easier to transport in Apple's optional soft carrying case.

Viewing Mac's video monitor, one is immediately struck by its apparent pinpoint clarity. This sense of sharpness is made possible by an impressive

video resolution of 80 pixels per inch, which translates to a total screen resolution of 512 by 342 picture elements. The machine's marvelous graphics capability is supported well by such crispness. It really comes into play when using the accompanying *MacPaint* which enables anyone to draw or "paint" on screen. Drawings can be printed effortlessly on Apple's Imagewriter printer.

Apple's use of Sony's 3½-inch disk drive, with its plastic-cased 400K-byte microfloppy, is decidedly different. Hewlett-Packard uses a similar drive for its HP-150 "Touch Screen" desktop computer, but H-P spins the disk at a constant speed, as nearly all disks are driven. Apple designers elected to use a variable speed so that more data can be put at outermost disk tracks. Moreover, Apple's drive version operates with 80 data tracks, while H-P employs a 70-track system. As a result, the Macintosh provides 400K bytes of storage in comparison to H-P's 270K bytes storage both on single sides.

Even starting operation by inserting a 3½-inch diskette is a new experience for computer users: there's no drive door to open or close. The disk automatically loads data into the computer's memory when inserted into the drive's slot. Moreover, you'll have to strain your hearing to detect any sound coming from the mechanical drive. It's that quiet!

Mac designers obviously borrowed some technology from Apple's larger, more costly Lisa series, particularly its graphics package, *Quickdraw*, and its mouse. But even where following Lisa's lead, the Macintosh includes major refinements.

Loading is fairly fast, unlike the original Lisa's tortoise-like pace. When it is complete, icons come up on the screen. Usually they include a diskette symbol with the name of its program spelled out and a drawing of a trash can for discarding unneeded files, along with a cursor arrow controlled by the external mouse. Across the top of the screen a choice of menus is spelled out.

To start the action, the user can roll the mouse up, down, left, or right; its movements are precisely mimicked by the arrow on the screen. To see the contents of a disk, simply position the arrow so that it points at the screen's disk icon and press the mouse's button once. A window then displays icons that portray the disk's contents. In effect, this is equivalent to the directory of a traditional disk.

A menu is equally simple to obtain. Just move the arrow to the top-screen bar and move the pointer to the menu you'd like to see. Click the mouse's button, and like a window shade the menu rolls down. Then move the pointer to your choice and click the button once again. With *MacWrite*, the

Mac word processor, pulling down the "style" menu reveals a selection of type styles—such as "bold," "italic," "underline," and so on—and a choice of type size, 9 point, 14 point, or whatever. To choose one requires only moving the arrow to the desired option while holding the mouse button down with a finger and then releasing the button when the choice is reached. Each choice is highlighted when the arrow points to it.

In contrast, a typical word processor requires a special code for each choice. For the ever-popular *WordStar* this would mean typing "`^PB`" while holding down the control key; for *Perfect Writer*, it would be typing "`B(`" in order to initiate this typeface. Furthermore, some or all of these special commands will appear on the screen, confusing the reader. Clearly, Mac's system is easier to work with.

The menu-selection bar contains a group of utilities as well. The icon here is an apple. Choosing this symbol will open a window of icons that represent desk accessories, such as battery-powered clock/calendar, a calculator, a notebook, and a scrapbook. Any of them can be called up while working with an application program, which is an enormous convenience.

For example, you might be in the middle of writing a business report and have to calculate some figures. With Mac, you can pull out an illustration of a calculator and, holding the mouse button down, move it to a convenient position on the screen. Then point the arrow and button-click whatever calculator keys you want to "press," and the calculator's display responds with the appropriate figures just as if it were a real device.

MacPaint, the \$99 Macintosh graphics/painting program, brings similar convenience to visual works. Using the mouse to select icons and labels, one can choose from among a host of graphics tools. Options include "spray paint," an "eraser," a variety of patterns, borders, shapes, lines, and so on, as well as a variety of font styles and sizes. A user can draw free-form as well. And illustrations can be integrated with text from, say, *MacWrite* and printed out with Apple's Imagewriter printer, the only printer now supported. (A letter-quality laser printer should be available by the time this review appears.)

Graphics drawing capabilities will doubtlessly be expanded by the introduction of new software that, for example, gives a user clip-art that can be used, much as is available to professional artists.

In addition to the ease in which charts and pictures can be created, together with text, the clarity of the displayed material is remarkably sharp. This

is owed to the use of a powerful, high-speed microprocessor, Motorola's 68000 CPU, and the MAC's bit-mapped video design. The 68000 32/16-bit microprocessor is superior to the IBM PC's 8088 16/8-bit microprocessor, and is the same device at the heart of Apple's advanced microcomputer, Lisa. The same machine language is used, too, for the amazing *Quickdraw* software.

Macintosh hides some great design work inside its case. A prime example is the 64K of ROM that forms the user interface. Here is where the Mac's management brain resides—the computer's operating system in firmware plus a lot more. Machine-language routines stored here provide the graphics and manage the mouse, windows, menus, icons, type fonts, et al. Application programs written for the Mac draw routines from it; in effect, part of any program for the Mac has already been written for programmers.

This revolutionary small computer does suffer a few drawbacks, some of which will be corrected in the near future. As with any newly designed computer, there's little software available right now. You can be sure that this will quickly be overcome; more than 100 software firms have announced that they are developing programs for the Macintosh, and enough Macs are being sold to ensure that these companies will follow through. Memory at 128K is too limited. But new memory chips are on the horizon soon that will double this amount. The extra is needed for serious business applications.

The absence of color is no big drawback for most uses, but it will be sorely missed by some. Color is indeed achievable, but it takes a big investment to make it happen. Look for third parties to give users such an option, though.

Unlike the Apple II, Macintosh offers no expansion slots. That doesn't mean you cannot add anything outside the computer, however. You can, but it's not as neat as an internal add-on board makes it. Peripherals will require their own power supply, which naturally will raise their price. A few have already been announced.

With no room for a coprocessor, don't plan on adding a Z-80 or 8088 system to this computer and running software you may have for them. Again, they may eventually be offered, but there is likely to be a considerable delay.

In addition to doubling Mac's RAM in the near future, you can be certain that Apple will introduce double-sided disk drives, doubling disk storage. As always, pioneers must pay a price for being first on the block.

The Macintosh-originated disks can be read by the bigger Lisa, but a Mac cannot read Lisa-gener-

ated disks. The Lisa has another enviable attribute that the Macintosh doesn't have. It can run more than one application at a time, whereas the Mac can only handle one at a time. The Mac does have a "Clipboard and Notebook" so that one application can be stored while another one is run. But two cannot be displayed together.

In line with the absence of expansion slots, the Macintosh is not designed so the user can open it up for modification or repair. Should anything go wrong, there are plenty of Apple-authorized service depots around. Clearly, this is not a hobbyist's dream.

The small desk area used by Macintosh is actually much larger than it appears. You need room for the mouse's travels; you need room for a second disk drive; you need room for a numeric keypad. Thus, the end package does not necessarily have to be the neat, little one the basic model appears to be.

Nevertheless, the Macintosh is a superb personal computer. Its operating ease will appeal to the many noncomputerists who don't want to fight their way through books and charts to operate a machine that was supposed to make them more efficient. Its built-in graphics, too, should attract many people. Add sharper-than-sharp video, handsome packaging, a moderate price—which Apple's automated factory and use of very-large-scale chips may reduce in time—and the company's financial durability, and the Macintosh is clearly the most important personal computer introduced since the IBM PC.

If anyone is in the market now for a sophisticated small computer, the Macintosh should be high on their list. Its reliability is probably the highest of any machine just beginning its production run. If you can put off buying a computer until higher-capacity memory chips are used, more printers are supported, and more software is available, so much the better.

Apple Computer, \$2,495

NEC ADVANCED PERSONAL COMPUTER III

When a company releases a new product which adds numbers or letters to an older product model, the consumer expects the new product to be a slightly upgraded version of the old one. NEC's Advanced Personal Computer III, to be released in the summer of 1984, seems to contradict that assumption, though at the time that this review is being prepared, there were only a dozen or so APC-III's in

existence and none were available for hands-on evaluation.

The original NEC APC includes a monochrome display which also houses the CPU and comes with 128K of RAM, a separate keyboard, and one dual-sided 8-inch floppy drive capable of storing one megabyte of data. Also included are a communications port, a parallel port, a serial interface and a battery-packed 4K CMOS RAM. This last feature helps in programs where you have specified parameters; the next time you start up the machine, you do not have to reinitialize since it remains in the CMOS RAM. The APC has five expansion slots and can be upgraded to 640K. It comes bundled with *WordStar*, *MultiPlan* and MS-DOS and can support most programs that run under MS-DOS or CP/M. If one uses the color monitor, he or she will be working in a high-resolution environment with 640 x 475 pixels and 8 simultaneous colors.

An interesting feature of the APC is that, while it uses the 8086 chip, which makes it a true 16-bit processor even in its data path, the user who utilizes the APC for extensive mathematical applications can remove the 8086 chip from the board, plug in a 2-inch by 2-inch board that has an 8087 chip on it, and plug the 8086 into that tiny, attachable board. Thus the user has the power of the 8086 coupled with the math co-processing capability of the 8087 chip.

The keyboard is quiet and feels a little like the keyboard on a VT100 terminal. Across the top are 22 programmable function keys, which are doubled by coupling them with another key. There is a numeric keypad with its own enter key, cursor controls, insert, and delete keys.

The APC will serve as an intelligent terminal emulator for the 3270 and for the 3278. The 3270 hookup is through a synchronous modem while the 3278 hookup is through coaxial cable. Each requires its own processing board. A number of APC's can be networked. The dirty work can be done off-line on the APC's and the data can be dumped, one screen at a time, into the larger computers.

The Advanced Personal Computer III utilizes the same 8086 with the choice of combining it with the 8087, and also comes with 128K expandable to 640K. But from the very first, it looks different from its counterpart. It is modular, so that the processing unit is all contained in separate housing. The monitor is larger (14 inches) and there is a port in the computer to allow one to hook up a second monitor. And instead of the 8-inch drive, it comes with one 5¼-inch drive. The computer is designed in such a way that the end user can easily remove

the drive, and the machine can be configured to have two 5¼-inch drives or a 10-megabyte hard-disk drive. There are four expansion slots (expansion to 640K requires only two of them). The APC III is significantly faster than the original APC, running at eight megahertz as opposed to five.

In addition, there is a 7220 graphics processor chip in the unit which provides 64K of dedicated monochrome graphics memory. If you install NEC's color graphics board, you've added another 128K of dedicated graphics memory and two more planes.

The keyboard is also of a different design. While there are fewer function keys (12), they team up with 4 other keys for a total number of 60 programmable function keys. Overall, there are more keys, and the keyboard is made with a template holder under it, so one can store unused templates for ready access.

The APC-III will come bundled with MS-DOS and GW BASIC and it will also operate under concurrent CP/M and runs under UNIX.

NEC, APC with monochrome display and processor, keyboard, 8-inch floppy disk drive \$2,748; with color monitor \$3,498; second 8-inch drive \$700; APC III: prices not yet released

NORTHSTAR ADVANTAGE

NorthStar has been in the computer business for a long time. Their S-100 "Horizon" was for several years the single largest-selling non-Apple, non-Radio Shack computer on the market. Today most of NorthStar's competitors in those days have vanished. The Horizon has evolved into a sophisticated multi-user, hard-disk system. And for small-system users, NorthStar has created a sophisticated small business computer that may be just right for your needs.

There is nothing innovative about the NorthStar Advantage; it is solid and conventional hardware. Several competing machines offer basically the same features: a 4 MHz Z-80A processor, 64K of memory, two disk drives, a built-in monochrome display, keyboard, and an enhanced CP/M operating system. This is all known territory, and NorthStar has assembled these standard components with unassuming competence. It's reliable equipment.

The NorthStar unit comes as one piece, with the two disk drives, keyboard, and display built in. There's also a convenient number pad for use in accounting and other similar applications. Across the top of the regular keyboard is a row of function keys, which may be programmed to work with

whatever applications software you are using. The keyboard is fairly good to type on, with reassuring tactile feedback. It took a surprising effort to make the keystrokes, but this may vary from machine to machine. Touch typists should have no problem adapting to the NorthStar keyboard, with its standard key positioning.

The Advantage comes with two built-in 320K disk drives. They use hard-sectored disks, which have several disadvantages. For one, it means their diskette format is incompatible with most of the rest of the industry. It prevents the NorthStar from being able to read in standard CP/M software written in one of the common 5-inch formats, such as the ones used by the Osborne and Kaypro. And it means that you must purchase special diskettes for the NorthStar to use; regular soft-sectored diskettes will not work. Even NorthStar dealers seldom keep a large stock of hard-sectored disks, and if they run out you may find it hard to locate disks when you need them. Just why NorthStar would stick with this oddball format for diskettes is difficult to understand; they don't gain any storage capacity by doing it, and in this industry incompatibility can mean lost sales.

Oddly enough, though this is basically a CP/M-80 machine, NorthStar does not offer CP/M as such; the standard operating system is G-DOS, a proprietary system, and they offer Graphics CP/M as an upgrade. It's compatible with commercial CP/M software but also allows you to take advantage of the NorthStar's 640 x 200 black and white graphics. This is good resolution and quite competitive with similar systems. The NorthStar does not use main memory for graphics; rather, the 20K of graphics memory is separate from main memory and handled on its own. This is an important advantage on a machine limited to 64K.

NorthStar also has its own BASIC, an offbeat variety that is incompatible with the industry standard *Microsoft BASIC*. In a good move for NorthStar customers, the company has announced support for either dialect, so that a number of commercial *Microsoft BASIC* applications can now be used directly on the Advantage.

If you want to expand the hardware, there are six slots to accept add-in boards. NorthStar supplies parallel and serial interfaces that allow you to drive printers, modems, and the like. There is even a floating-point processor board to speed mathematical calculations. It is almost certain that you will have to add at least one parallel or serial port; as it stands, the Advantage has no way to connect with a printer or modem. This may be the one really substandard aspect of the machine.

You can also plug in various special boards to tie the NorthStar into a larger network; this permits shared use of costly facilities, such as printers or disk drives. You may find this a particularly cost-effective method of setting up your computer system. NorthStar has a good network system, providing shared resources and electronic mail. If you need to purchase several computers or work stations, then it is especially worth considering.

Since there is a general move toward IBM software and MS-DOS compatibility, the NorthStar Advantage is now offered with an 8088 co-processor board. This is very much like the Xerox 8088 board or the ATR-8000's Co-Power 8088 board. It offers 256K of memory, runs at 5 MHz, and supports MS-DOS. As usual with IBM compatibles, if the software you want to use does not make any IBM-dependent software calls, then all will be well; if it relies on the IBM hardware it will not work.

Fortunately, this is less and less of a factor; with the number of PC compatibles on the market, software manufacturers are being forced to stick with the generic MS-DOS guidelines. Much of the incompatible software stems from the early IBM days, while MS-DOS was still struggling for acceptance as a 16-bit standard. The Advantage system with the 8088 co-processor is the Advantage 8/16, and retails for \$3,400, \$399 more than the basic Advantage.

The 8088 board offers a significant advantage in speed when used with several popular programs. For example, with the larger memory address space, the 16-bit version *dBASE* runs more quickly than the 8-bit original. There is also a 16-bit edition of *Wordstar*, *Spellstar*, and *Mailmerge*, but Micropro converted these programs from the 8080 editions without taking advantage of the extra memory available with a 16-bit system. A variety of programming languages is available, including both interpreted and compiled versions of BASIC-16, Pascal-16, Fortran-16, and COBOL-16.

NorthStar offers a choice of two hard disks, 5- and 15-Mbyte models. These are remarkably inexpensive. For instance, an 8/16 system with a 5Mb hard disk is priced at \$4,900. Though the IBM PC could slightly better this price when combined with the least expensive third-party disk subsystems, it is more than competitive with the IBM PC/XT and offers networking and software features that are available only with extra cost with the IBM. The extra speed and convenience of a hard-disk system is well worth NorthStar's surprisingly reasonable price.

The NorthStar system includes not only this choice of hardware, but some very good software

as well. In use for several years, it is thoroughly debugged and reliable. This software may be the greatest difference between the NorthStar and several competitive machines.

The package centers on the Total Business Solutions family of accounting software. It has several parts, all aimed specifically at the small business user. The two major packages are *ACCPAC* and *PROPAC*. *ACCPAC* provides an automated accounting system, accounts payable and receivable, general ledger, order entry and inventory control, and payroll. *PROPAC* is a professional time management and billing package, with a database of client profiles, client time and billing, and client receivables. Add to these packages *INFOMANAGER II*, a menu-driven database management system. It is more than adequate for most database applications, and its files are compatible with NorthStar's accounting packages. Next, there's *NorthWord II*, a word processor, and *NorthSpell*, a spelling checker. And finally, there's *NorthPlan*, an electronic spreadsheet.

None of these is the cheapest software package in its field. But for a complete system, they offer one major advantage: These packages can communicate with each other. If you bought another CP/M system, you could certainly find software to handle each of these individual functions; for instance, you could get *WordStar* for word processing and *dBASE II* for database work. But it can be far from easy to trade data files between *WordStar* and *dBASE II*. Add a spreadsheet to the mix, and you'll have all sorts of problems. That's why the integration of the NorthStar system is useful.

One question about NorthStar is dealer support. The Advantage is sold by fewer than 400 computer stores in the United States. While this is enough to ensure at least a little hand-holding while you are getting used to your system, dealers are not likely to be able to handle serious hardware repairs. NorthStar has only five regional sales offices, one in Texas, and the rest east of the Mississippi, and even these reportedly have been less helpful than might be wished. This appears to reflect the firm's origins, selling S-100 computers and kits to early hackers. Thus, it's best to make sure of who will service your computer before buying the NorthStar Advantage.

NorthStar has managed to achieve what many other computer manufacturers have not been able to: a complete, well-integrated package of hardware and software that effectively covers most small-business needs. Their prices are quite reasonable, particularly for hard-disk systems. In all, the NorthStar is an effective personal computing system.

NorthStar Computers, Advantage \$2,999; Advantage 8/16 \$3,300; Advantage 8/16 with 5MB hard disk \$4,899; 8088 coprocessor card \$399; Serial card \$175; Parallel card \$200; *NorthWord* \$199; *InfoManager* \$399; Graphics CP/M \$299

SONY SMC-70

Sony is marketing this system with special emphasis on its graphics capabilities. It is not clear that this was intended from the beginning, but it is certainly a wise move. The quality of the color graphics on the SMC-70 is impressive for any microcomputer, and doubly so for a CP/M machine. The decision to stress that feature gives Sony salespeople something to brag about. It also makes the system's deficiencies seem much less important.

That last sentence isn't meant to be as ominous as it sounds. It's just that, to be honest about it, the SMC-70 has some design flaws. Before you get carried away with what's good about the system, you ought to be aware of the drawbacks.

There is, in particular, the keyboard. At first glance, you might mistake this for a chiclet keyboard. It's not, but unfortunately, it has some of the same problems. When typing, you will find a comfortable constant pressure pushing back at you throughout the keystroke, but you will also find that the tops of the keys are nearly flat and are smooth enough to feel slippery. Worse, the keys are so wobbly that one would be tempted to label the keyboard as "cheesy" if the rest of the system didn't have such a solid feel to it.

Wobbly or not, the keyboard might still be tolerable if it had a reasonable layout. It doesn't. This is yet another entry in the contest for who can design the worst possible keyboard for touch typing. It's one of the stronger contenders.

On this keyboard, the left Shift key is in the standard position, directly to the left of the Z, but the right Shift key, the Return key, and Backspace key have all been moved one step further to the right. None of this will bother you if you're not a touch typist, but it will rapidly be revealed as a problem if you ever decide to become one. The three keys are simply too far away to reach comfortably.

On the bright side, the keyboard has a row of function keys across the top, plus four Arrow keys for cursor control. The Arrow keys are intelligently arranged in a diamond pattern—top for cursor up, bottom for cursor down, and so forth. A numeric keypad is also available as an optional unit.

The color screen is another place where the SMC-70 does not qualify for serious word processing or data processing. The Trinitron monitor is

terrific for color graphics (more on that shortly), but it is simply not suitable for staring at for hours at a time for reading text. Sony also offers a monochrome monitor that is much more appropriate for such work, but given the problems with the keyboard, this system is still not a serious contender for heavy duty word processing.

What the SMC-70 does brilliantly is graphics. In fact, this is one of the few microcomputer systems—certainly the first CP/M system—that has a built-in bias for graphics processing.

The term "graphics processing" is carefully chosen, in direct analogy to word processing. Sony has available a graphics editor for the SMC-70. This does for art what a text editor does for words. It lets you enter your visual ideas easily, move them around, cut and paste, change sizes, change colors, draw simple or complex shapes, and otherwise manipulate visual concepts on the screen as easily as a good word processor will let you manipulate words.

The speed at which this graphics editor works is impressive. It's also simple to learn, simple to use, and even fun. It won't automatically make you a great artist, but it will let you create anything from bar graphs to fairly complex drawings quickly and easily. And it will let you save them on disk. A companion program, *Video Titler*, will let you add type to your graphics in a choice of up to six fonts. The one major feature lacking from the system is the ability to print the color graphics or make slides from them, but the Sony does support third-party equipment for slide production.

The only choice for hardcopy from the graphics program on the basic Sony system is in the form of "line drawings" on the Sony dot-matrix printer. The printer is surprisingly good for a dot-matrix—in printing text, it is very nearly correspondence quality—but it is not suitable for finished art. Even without high-quality hardcopy, however, you can use the graphics in a kind of video slide-show presentation, either with the Trinitron monitor, or with Sony's projector television. This is the feature that Sony plans to emphasize in its marketing.

In dealing with graphics, incidentally, the defects of the keyboard become irrelevant. The only keys that matter are the Arrow keys, and these are fine. Their four-points-of-the-compass design makes cursor movement intuitively obvious. A 12-by-12-inch graphics tablet is also available. This works with the Sony *Graphics Editor*, version 1.2.

In addition to the graphics, most people are immediately impressed by the microfloppy drives on the SMC-70. The 3½-inch 280K disks for these drives are well protected in a hard-shell plastic

case. The only opening is a small oval area, which is needed so that the drive can read from and write to the disk. When the disk is not in use, a metal slide covers even that opening, and minimizes the risk of accidentally ruining the disk. The 3½-inch microfloppies are beginning to show up on other machines as well and are likely to become a new standard.

A point often missed is that the microfloppies are optional. If you prefer, you can buy the system with a disk-controller card for standard 8-inch disks. The Sony controller card will not let you use 8-inch disks by themselves, but Computer Curriculum Corporation of Palo Alto, California, sells a disk controller and drive for the Sony that will let you boot off the 8-inch disk. You can get software and the CP/M operating system in this format from Sony. The Sony disk-controller can read and write single-sided, single-density format. The CCC disk controller will read and write any of the standard 8-inch formats—single-sided or double-sided, single-density or double-density.

The point is that most features on this machine are optional, and the system is nothing if not flexible. You can tailor your own package if you like, or you can pick one of Sony's standard configurations. The packages are less expensive than putting the system together piecemeal.

The basic machine is a remarkably unremarkable Z-80 computer with 64K RAM. Another 38K RAM is devoted to graphics and character display, while 32K of ROM (read-only memory) holds the system monitor and Sony BASIC. The system also includes an RS-232 port and a Centronics-compatible printer port (using a DB-25 connector). The operating system is extended CP/M. The extension gives you the color capabilities, but otherwise this is standard CP/M and will run off-the-shelf CP/M programs—with the usual hedge that any given program may or may not actually work.

There's also one other hedge. If you think of the SMC-70 as a standard CP/M machine that also has color graphics, you are likely to be disappointed by it. Think of it instead as a graphics-processing machine, but one that will let you run CP/M programs as a bonus. This will not only give you a handle on what this machine is about, it will let you appreciate the SMC-70 for what it really is.

Sony, The four bundled packages each come with dual microfloppies and 64K RAM: Generalist package with monochrome monitor, dot-matrix printer, word-processing software, *SuperCalc 2*, all necessary cables \$3451; Artist's Easel package with Trinitron monitor, disk BASIC, Graphics Editor, all

cables \$2691; Manager package with Trinitron monitor, Record-Management software, *SuperCalc 2*, all cables, \$3036; Bookkeeper package with *Trinitron* monitor, dot-matrix printer, 6 MB hard disk, *ADS Accounts Receivable*, *ADS Accounts Payable*, and *ADS General Ledger* software, \$6700. Other systems can be pieced together at a range of prices. The graphics-tablet option is \$770 with stylus, or \$810 with cursor device.

TANDY 2000

After IBM introduced its PC and immediately gained not only the lion's share of the personal computer market, but a host of clones using the same operating system and as nearly the same hardware implementation as it could without engendering lawsuits, industry observers en masse wondered what, if anything, Tandy might do.

Would it introduce yet another clone? Or would it provide an "IBM-compatible" 8088 add-on for one of their existing computers? Or, considering its commitment to the 68000 and Xenix in the Model 16, would it do nothing?

It was not until the COMDEX show in late 1983 that Radio Shack announced its answer: the Tandy 2000. Tandy chose not to make just another clone of the IBM PC. Instead, they chose to use the Intel 80186 processor, a true 16-bit chip data path to memory, and Microsoft's MS-DOS 2.0. Thus, they elected a processor compatible with the 8088 and a DOS used by the IBM PC, but managed to go Big Blue one better.

The positive side of this decision is that the Tandy 2000 runs nearly three times as fast as the IBM PC; the 2000's floppy drives have four times the storage capacity of the standard IBM drives; and the resolution of the screen display is twice the resolution of the PC, with twice as many colors. And, the Tandy 2000 costs about \$650 less than an IBM equipped with a second drive and the other PC options that come standard with the 2000.

Inevitably, there is a drawback as well. It's that the 2000 will run only software that conforms to straight MS-DOS standards and does not depend directly on hardware features unique to the PC. Thus the 2000 cannot use about half of the PC programs now available. It also cannot use the plug-in boards designed for the PC. The software problem is becoming less significant each day; there are so many not-quite-compatibles on the market that programmers have begun to adhere to the standard MS-DOS features and ignore the IBM hardware. But there is nothing to be done about the boards; until third-party vendors begin to produce

accessories for the 2000, Radio Shack's own equipment is all that will fit.

The 2000 is organized as a separate keyboard, CPU unit with contained disk drives and extra board space, and separate monitor. The appearance is a pleasant off-white and the overall design is attractive.

The CPU unit may be set up under the monitor and behind the keyboard, as is most often done, or in an optional floor stand, which mounts the unit vertically alongside your desk. The nameplate swivels to fit either set-up. The CPU unit has front mounted On/Off and Reset switches. The two thin-line double-sided double-density disk drives are horizontally mounted at the right front of the CPU.

On the back of the CPU unit are the connections for the monitor, including an AC outlet, the parallel printer port, the RS-232 port, and four plug-in card slots. An additional 128K RAM may be added without using an additional card slot. There is no way to add external disk drives.

The base model 2000 comes with a keyboard, 128K RAM, and dual floppies and is priced at \$2,750. One may add the 12-inch high-resolution green phosphor monitor for \$249, bringing the minimum operational system in at just under \$3,000.

Alternatively, one may add the high-res monochrome graphics board, the high-res color graphics chip kit, and the high-res 14-inch RGB color monitor. In all, they bring cost of the minimum hi-res color unit to just under \$4,200. This review was conducted primarily on this configuration.

A version with one 10-megabyte hard disk and one floppy is \$4,250 as compared to the \$2,750 for the all-floppy version. A combination of the hard disk and color brings the cost to about \$5,700.

The keyboard is relatively thin and light, with retractable legs on the rear for adjusting to a comfortable typing angle. Attached with a six-foot coiled cord, it may also be moved around for the user's convenience.

The keyboard follows the Selectric layout. It provides 90 keys, with 12 function keys and a ten-key numeric keypad. A NUM lock key can be used to assign the numeric keys to alternate uses. The arrow keys are arranged in an inverted T. Keys also included are ALT, Control, ESCape, Insert, DELeTe, Break, Home, Print, Hold, Tab, and Backspace. The layout is logical and easy to use.

The keyboard's feel is uncommonly good. Even a hunt-and-peck typist pronounced it the first keyboard he had used that seemed significantly better than others.

The monitor used for testing was the 14-inch CM-

1 color monitor, which may be placed on top of the CPU or directly on the desk. If the VM-1 12-inch green phosphor monochrome monitor is chosen, it may be mounted on an optional tilting and swiveling monitor pedestal.

In either of the monitors the standard text display shows 80 columns by 25 lines, but an alternate layout of 40 columns by 25 lines is also available. The character set is said to be user definable, but this feature was not tested.

The color monitor with 640 x 400 pixels resolution and displaying up to eight colors was the equal of some with systems in the \$10,000-and-up range and superior to anything in available at the Tandy's price. The crisp color charts and graphs must be seen to be appreciated fully. The speed of the color display in painting areas of a chart was also impressive.

Used in the monochrome mode for conventional DOS and other program operations, the character set is well formed, legible, and pleasant. Two scrolling speeds are available, one about medium reading speed, the other typical of fast scrolling.

The standard model comes with 128K RAM, and this is expandable to 768K, the first additional 128K not requiring an additional card. Adding at least some extra memory is a good idea when the high-resolution monochrome graphics card is used. When BASIC is loaded and memory is allocated for management of the hi-res graphics, less than 30K remains for execution of BASIC programs. At least 256K RAM is therefore desirable, though users not running large BASIC programs might get by with 128K. If the high-res board is not added about 48K remains for BASIC program execution after BASIC is loaded.

To obtain more than 256K, another RAM card must be used. It includes 128K and will accommodate an additional 128K RAM.

A socket is provided for an 80187 math processor. This would be attractive to anyone who requires large amounts of number crunching, but as of this writing Tandy has not confirmed this option.

The monochrome graphics board also supports the color high-res graphics, but an additional high-resolution graphics chip kit must be added to that board when color is used.

The additional cards, or boards, are considered user installable. All that is required is to slide the board into a slot until 30 or so pins slip into their connectors. However, in sliding one card in, the net result was that the machine went out and had to be returned to a Radio Shack Computer Center. The diagnosis: A pin connector had not been exactly aligned and was bent when the board was pushed

home. There is no way to know at this point whether this will be a common problem, but take care when installing cards.

Announced but not available for review is a Digi-Mouse/Clock Board that provides the controller for the optional Digi-Mouse, a clock, and accommodation and software for the Microsoft *Windows* operating environment. The *Windows* system is quite promising and has been endorsed by most of the hardware and software industry, with the notable exception of IBM.

There is no way to add external storage beyond Tandy's hard disk. We understand that it is theoretically and physically possible to have the two floppies and the 10 Meg hard disk, but Tandy has not yet indicated this as an offered option. Our own view is that for a single user machine, the external storage now offered will be adequate for all but a few users.

A TV/Joystick Option allows connection to a TV, and includes a graphics and sound generator. It does not seem likely that many users of this class machine will be interested in such an option, however.

Although Tandy obviously set out to surpass rather than "copy-cat" the IBM PC, the 2000 will nonetheless run a portion of the IBM PC software. From a listing furnished by Tandy it would appear that something like half of the available PC software would fall in that category.

Some of the most popular IBM programs will not run, however. The most prominent, *Lotus 1-2-3*, will not run as-is, but Lotus has already announced that a Tandy 2000 version is in the works. Sorcim's *SuperCalc3* is another example in the same category, and it is probably reasonable to expect that other software vendors will follow suit in making items available in a Tandy 2000 version.

Software confirmed by Tandy to be available includes: *PFS:Write*, Microsoft *WORD*, *Multimate*, *PFS:Graph*, *PFS:File*, *PFS:Report*, *dBASE II*, *Multiplan*, MAI's accounting series, *Videotex Plus*, and *Home Accountant Plus*. Languages include *MS-Pascal Compiler*, *MS-GW Basic Compiler*, *MS-FORTRAN*, *MS-Assembler*, and an MS-DOS version of *RM-Cobol*.

Two available MS-DOS applications programs ran on the 2000 without difficulty. The most notable feature was the speed of execution. *PFS:File* did a comparable task on the 2000 about four times as fast as on the TRS-80 Model 4. Another program, *Home Accountant Plus*, was designed for a color display. It is not easy to justify the use of color in ordinary business applications such as an accounting program, but in this case the color does

much to make things easier and more pleasant—just as highlighting or reverse video, used in a menu often does with monochrome.

At this stage in the computer market, deciding whether to buy a given machine almost inevitably means trying to figure out where the market as a whole is going. Tandy was not alone in introducing an 80186/MS-DOS computer at COMDEX; there were 20 or so others. So which are you better off buying? An IBM, with an 8088 and hardware peculiarities that the computer market has been forced to treat as a standard? Or a machine that uses straight MS-DOS, the hot new *Windows* package, and an 80186—a contender for the post-PC standard.

It is widely believed that IBM also has an 80286 machine in preparation for release whenever they feel the market is right for it; at this writing they have not confirmed it. If they do, will they again embrace some hardware peculiarities, an IBM proprietary DOS, or both? Or will they produce a machine that can run software by using the DOS instead of one in which DOS must be bypassed in order to get acceptable performance. And, will software vendors again write hardware-specific software or will they support MS-DOS and *Windows*, running on many different computers?

Certainly it is far better for the consumer to have many hardware vendors providing machines for a common DOS than to have one setting the standard for both DOS and hardware. Tandy and several other major manufacturers of both hardware and software seem to be betting that this factor will turn the market around and force IBM to compete on a more even footing.

Note also that this is a *Tandy 2000*; it does not carry the Radio Shack label. It seems that Tandy hopes to penetrate the big business market, where the Radio Shack image may be a handicap.

If Tandy is right and the overall market swings their way, and if they manage to penetrate the business market, the Tandy 2000 could turn out to attract wide support from outside vendors of both software and add-ons. If not, it will still be able to use at least half the programs available for the IBM, and it will still have the traditional hardware support from Tandy itself.

Alas, however the market finally moves, it seems likely that the Tandy 2000 and other 80186/MS-DOS machines there will suffer a relative lack of software and add-ons for some time to come.

No one should rule out the Tandy 2000 on that basis alone, however. Nothing as of this writing offers as high a ratio of performance to price. It surpasses the IBM PC on every front except add-

ons and software available from third-party vendors. And there isn't much that one could want that isn't there or coming. You can have speed, memory, a good DOS, a windowing capability, dazzling hi-res color graphics, and a mouse controller if you want it.

Anyone still mesmerized by the IBM nameplate would do well to wait for their 80286 machine and see how well it stacks up in prices, performance and features. But anyone else in the market for this class single-user machine could confidently buy the Tandy 2000. Now.

Radio Shack, Two-disk system \$2,750; Hard-disk system \$4,250; High resolution monochrome graphics \$449; High resolution color graphics chip kit \$199; TV/joystick adapter \$249.95; Digi-Mouse \$99.95; Digi-Mouse/clock controller board \$119.95; VM-1 monochrome monitor \$249; CM-1 color monitor \$799; Monitor pedestal \$89.95; Floor stand \$145; Internal 128K RAM kit \$299; External 256K expansion board \$499; 128K RAM upgrade \$299; internal 10 MB hard disk \$1,699

TELEVIDEO 803

The TS-803 is TeleVideo's lowest-priced desktop computer, designed to be used either as a stand-alone, or as a work-station in a TeleVideo multi-user network. It contains an 8-bit, Z-80 CPU, 64K of user RAM (which can be expanded to 128K) and 32K of graphics RAM. Two double-sided, double-density disk drives give you 340K each in the standard configuration; an optional version (The 803H) replaces the second floppy drive with a 10-mega-byte hard disk.

The first thing one notices about the TeleVideo 803 is that it doesn't look like your run-of-the-mill computer: Instead of the usual square box, there is a large, tiltable screen suspended in a cradle, to the right side of which is attached a narrow tower housing two thin-line 5¼-inch drives mounted vertically, one above the other. A detached keyboard plugs into the base of the tower. This unusual design allows for free airflow around all the internal components of the computer and eliminates the need for a fan. The result is that less power is consumed and operation is completely silent at all times: This is one computer that you can turn on in the morning and leave on all day long without any distracting noises or worries about overheating.

The large green-phosphor screen, measuring 14 inches diagonally, displays 24 lines of 80 characters on a nonglare surface. The characters themselves, formed by an 8x8 dot pattern, are highly readable, even from a greater than usual distance,

because of the size of the screen. A knob on the rear of the tower adjusts the contrast, which is excellent under normal lighting, but may appear somewhat dim under very bright lights. The screen can also display graphics with a 640 horizontal by 240 vertical resolution.

The keyboard, which plugs into the base of the main unit, is similar in layout to that on the TeleVideo 950 terminal, but is set into a large, sloping base which gives the user a comfortable palm rest while typing. Along the top are 16 function keys, which can be shifted to give a total of 32 fully programmable functions. To the right are a numeric key pad and several additional screen control keys that are used when the computer is emulating a terminal. The keys themselves have an excellent feel and few users will need to turn on the programmable keyclick (which is more like an electronic peep).

The back of the vertical tower has the power switch, a ten-position dip switch to select various setup defaults, the receptacle for the power cord, and two connectors for the two serial ports—one configured for a printer, the other for a modem. A modular plug is also provided to attach TeleVideo's optional "Super Mouse." The dip switch sets the baud rate for both ports at the same time. However, this can be overridden under software control so that devices operating at different speeds may be connected to the two ports. The switch also allows selection of either green on black (the default display) or black on green characters on the screen.

Like all of the stand-alone TeleVideo computers, the TS-803 allows users to install an optional RS-422 high-speed port, enabling the computer to function as a work-station on a TeleVideo multi-user networking system under TurboDos or MPM-II. The "Format" utility that comes with the TS-803 permits formatting disks either for a stand-alone or for these different multiuser systems.

Software supplied includes the CP/M 2.2 operating system with the GSX graphics extension and a number of additional utilities for fast disk copying, for configuring the system's parameters and a demonstration program which shows off the system's graphics capabilities. The GSX extension to CP/M allows any programs using this standard protocol to create graphics directly on the screen of the TS-803 using a 32K graphics memory that is independent of the system memory. Drivers are also supplied to handle an Epson printer and Hewlett-Packard or Houston Instruments plotters. A package called TeleSolutions, which consists of the same software (*TeleWrite* and *TeleCalc/TeleChart*) that is provided with the TeleVideo TPC-I

portable computer, is also included in the purchase price.

The setup utility supplied with the computer allows a number of hardware and software options to be set directly from a menu. These include configuring the serial ports individually, attaching or detaching a mouse, changing the I/O byte (several protocols can be selected in this manner for a serial printer), and setting an autoloader file name to be executed automatically on a cold boot. The configuration can be saved temporarily or permanently on the current disk. A "Time Of Day" program is also supplied, which sets a system clock to the current time and date (as in CPM-86). This clock will keep approximate time as long as the computer is not cold-booted.

Documentation consists of the "User's Manual" which is brief but clear and well-organized. Almost every subject needed by either a beginning user or a systems programmer is covered in a no-nonsense manner, with ample illustrations, reference summaries, a glossary, suggestions for further reading, and a full index.

The computer comes ready to run, right out of the box: All the buyer has to do is plug in the power cord and the keyboard, press the power switch and insert the systems disk into the "A" drive. A complete novice can read the first few chapters of the user's manual and be up and running within minutes. The high degree of compatibility between TeleVideo's computers and terminals means that most software can be purchased already configured for the TS-803, or can be easily installed by the user.

The TeleVideo TS-803 is an excellent entry-level computer for a small business. It takes up little more desk space than a typewriter, its large screen and ergonomic keyboard make it an excellent word-processing machine, and its totally silent operation is a real pleasure in an office. Since it can be linked into a multiuser system, a company that purchases one or more of these computers can easily expand from this base to a more substantial computer network without losing any of the original investment in either hardware or software. TeleVideo has established a better than average record for quality control with its terminals and the TS-803 seems to carry on in that tradition, being considerably sturdier than most computers in its price range. It comes with the usual 90-day warranty and on-site service is available from TRW nationwide.

TeleVideo, TS-803 with two floppy disks \$2,495; with one floppy and a 10-megabyte hard disk \$3,995

TELEVIDEO 1603 and 1605

TeleVideo originally entered the 16-bit computer market with the TS-1603, essentially a 16-bit version of their popular TS-803 8-bit computer. The 1603 comes with 128K memory (expandable to 256K), two quad-density 5¼-inch disk drives (706K useable capacity each), and optional graphics capabilities. The 1603 is a capable machine, running under the CP/M-86 operating system, and fits in well with TeleVideo's multiuser office networking systems, but it is not at all IBM compatible and therefore has had little effect on the market.

Realizing that the IBM PC has set the standard for 16-bit microcomputers, TeleVideo came out with the 1605 in 1984. It is also called the Tele-PC in the company's literature. The 1605H is called the Tele-XT. These computers are highly compatible with the IBM PC and PC-XT respectively.

The 1605 does not look at all like an IBM PC—it is being built with the same basic components as the other desktop TeleVideo computers and terminals: a large (14-inch diagonal) green screen suspended in a cradle to the right of which is a narrow tower containing two vertically mounted thin-line 5¼-inch floppy disk drives. The keyboard, which attaches to the front of the computer with a coiled cable, has the general layout of the IBM PC keyboard, but is set into a large, sloping base and is quite different in feel and size. Templates for the IBM keyboard will not fit on it. The back of the tower contains the power switch and power cord receptacle, a dip switch for setting hardware options (memory size, graphics mode and math coprocessor), two 25-pin connectors for the built-in parallel and serial ports, a contrast control for the screen, and outlets for a separate color monitor. A plastic shroud covers the built-in expansion slot.

The 1605 has only one expansion slot, which will take most boards designed for the IBM PC. An optional expansion box, the 1605E, will give the user six slots for IBM-compatible add-on boards. Since the parallel and serial ports in the 1605 cannot be changed, one must be careful not to add any boards using those port addresses (LPT1 and COM1). Inserting a board into the 1605 is fairly difficult compared to the IBM or other compatibles: It requires taking apart the tower enclosure and disconnecting the disk drive cables before the board can be inserted. If frequent access to accessory boards is required, the additional expansion box is almost mandatory.

The 1605 comes with 128K of memory standard, which can be upgraded to 192K or 256K internally by adding 64K RAM chips. The 1605H comes with 256K of memory standard. The circuitry is designed

to work with the new 256K RAM chips as well, so that the memory will be expandable to 512K internally when these become more generally available.

The display has the same 14-inch green phosphor screen found on the TeleVideo 803 and 1603 computers, but it operates like the IBM color/graphics board using a monochrome display, meaning 16K of graphics memory and a 640 by 200 resolution. The display is clear and readable, and does give you graphics capabilities, but does not have the fine resolution of some other monochrome displays, or of TeleVideo's other computers. A separate color monitor can be attached (both composite and RGB connectors are provided). A model with a built-in color screen (the 1605C) has been announced by the manufacturer for release sometime in 1984.

Software supplied with the 1605 consists of *TeleDOS* (MS-DOS 2.11) and *TeleBasic* (Microsoft *GW-Basic*), which are essentially the same as IBM PC-DOS 2.10 and *BASICA* respectively. No other software is available from TeleVideo, but almost any software that runs on an IBM PC will run on the 1605 (including *Lotus 1-2-3*, *Microsoft Flight Simulator*, and other programs frequently used to test IBM compatibility). One can also run the 1605 using IBM's PC-DOS, as well as CP/M-86 and Concurrent CP/M-86 for the IBM PC. TeleVideo claims that the 1605 is "As compatible to the IBM PC as any machine on the market today," and it would appear that they are correct in that assessment.

The documentation consists of the "User's Guide," and manuals for *TeleDos* and *TeleBasic*. The "User's Guide" is a brief and well-illustrated introduction to the system, designed to have even a novice using the computer in minutes, while it also answers most of the questions a new user would be likely to ask. The *TeleDOS* and *TeleBasic* manuals are barely adequate, appearing to be little more than typewritten copies of Microsoft's own documentation with many of the technical details left out. Since the 1605 runs just as well under PC-DOS, users may well wish to buy that operating system from IBM just to get the better documentation that comes with it.

Like other TeleVideo computers, the 1605 and 1605H rely on convection cooling and have no fan. This allows for totally silent operation and for less likelihood of mechanical breakdowns or power supply problems. TeleVideo computers tend to be well made—the company has excellent quality control for all of its products and the 1605 series seem to be no exception.

If the TeleVideo 1605 or 1605H happen to supply exactly what the buyer needs in a microcomputer

system, their prices are quite competitive. Unfortunately, once one starts to look at options and attachments, the TeleVideo computers are much less attractive than many of the other PC look-alikes: The built-in monitor is not much of a saving if one needs color graphics, and if one does not need graphics at all, it does not have the fine resolution of the IBM monochrome display or some other combined monochrome and graphics displays. Adding accessory boards can add considerably more to the price if one has to buy the expansion adaptor, and some of these, such as enhanced graphics boards, cannot be used at all.

TeleVideo, 1603 with 128K RAM \$2,995; graphics for 1603 \$495; 1605 \$2,995; 1605H with hard disk \$3,995; 1605E expansion box \$349

THE TEXAS INSTRUMENTS PROFESSIONAL COMPUTER

For a second time, Texas Instruments has broken off onto a different path from the mainstream computer manufacturers. The first foray brought the ill-fated TI-99/4, which just recently found its deserving and final niche in computerdom-oblivion. The second offering, from TI's Data Systems Group, is the Texas Instruments Professional Computer. It is a radical and welcome departure from the physical architecture and bubblegum styling of the 99/4. And though it is an IBM PC work-alike, it is hardly another PC clone. Indeed, the Professional Computer eschews much PC compatibility, opting instead to improve many of the features found on the IBM entry.

The computer can be broken down into three components: the display, the system box, and the keyboard. The basic system comes with 64K of RAM, a double-sided, double-density 320K disk drive with built-in controller, a video-display adapter card, a monochrome or color monitor, and a 97-key detachable keyboard that seems to have actually been designed by a human being.

The motherboard is contained in the system box, which also houses the disk drives and power supply. The system is driven by a 5MHz Intel 8088 microprocessor with an additional socket provided for an 8087 arithmetic coprocessor. It supports only 64K of 4164-type dynamic memory devices in a nine-chip configuration that includes parity. Six expansion slots are available for plug-in boards, with one slot reserved for an additional 192K RAM board, for a total of 256K. Another slot is used by the basic video display card, leaving four open. You can increase memory even more by inserting TI's new 512K memory card in any open slot, bring-

ing the system up to a whopping 768K. Also inside the unit are 8K of ROM, a Centronics-type parallel port, an input/output port for the keyboard, and a speaker.

The Professional is loaded with intelligently designed touches. The 8K of ROM contains all controlling software for the keyboard, disk drives, and other principal input/output devices. When you turn on the machine, these hardware instructions are transferred to the lowest 1K of memory. When one of these routines is functional, two registers (holding areas) in the 8088 are used. One of these controls the address where the routine can be found. By changing this address, you can customize device routines to redefine the keyboard, among other things.

Similarly, each peripheral card has its own ROM that's encoded with its own controlling software. And the ROM that controls the 320K disk drive also has instructions sets for supporting drives of 640K. You can activate these instructions, once suitable drives have been installed, by modifying one jumper on the mother board. The disk controller, Western Digital's FD1793-02, WD1691 and WD2143, is part of the main system board and requires no expansion slots. There is an onboard 40-pin connector that can be used for two additional drives. If you're using standard height units, these additional drives would have to be mounted externally; four half-height drives, however, can be mounted in the system box. The 160-watt, switching power supply can handle the load admirably.

The keyboard is a marvel of human engineering, otherwise known as ergonomics. It can be set at any angle between 5 and 15 degrees, and it's divided into four distinct regions. The touch is firm and tactile and without the harsh clack so many other manufacturers seem to favor. The coiled cord stretches to about five feet, and a tap at the upper corners releases a full-length leg that elevates the keyboard.

The main keyboard occupies the bulk of the surface. It follows the standard typewriter layout, with wide shift keys, an L-shaped return key, a proper-width tab key, and an additional key to generate linefeeds. The A and Control keys are located far enough to the left to keep you from pressing them by mistake, and the Caps Lock key, obligingly, is equipped with an LED to signal its use. Touch typists will appreciate the inclusion of indentations on the F and J keys. For those without an international bent, the return and tab keys are both clearly labeled in English.

Some small distance to the right of the main keyboard, there are four arrow keys logically arranged

in a diamond pattern around a Home key. Farther to the right is the numeric keypad. The Professional's keypad, however, is more than just a collection of numbers. There are Plus, Minus, Equal, and Decimal-point keys, as well as Space, Enter, and Tab keys—carry-overs from the main keyboard.

Above these three sections, a finger's reach away, is an additional row of 16 keys, divided into four groups of 4 keys each. Three of these groupings (12 keys), located above the main keyboard, are definable function keys. Each generates an ASCII code when pressed. When used in conjunction with the Shift, A, and Control keys, different codes can be generated, effectively yielding 48 possible values.

The last grouping of four keys is above the numeric keypad. These are for Insert, Delete, Break/pause, and Print. This last deserves a note of explanation, since it does nothing on its own. When you press both the Print and Shift keys simultaneously, an interrupt vector is generated. Under program control, this interrupt can be monitored so that you can print whatever is on the screen.

The keyboard itself is a serial device with a 15-character buffer. It's controlled by an 8048 processor and is bidirectional, sending characters at 4,800 baud and receiving them at 300 baud through an 8251 USART. At power up, a diagnostic query is sent out to determine the system's status.

The quality of the TI video display is immediately apparent. The sharpness of its characters is equalled only by the Vector Graphic 4 series and the Victor 9000. The basic display produces a 7 x 9 pixel character in a 9 x 12 cell. With a display width of 80 characters and depth of 25 rows, the video matrix provides 720 x 300 pixel resolution. The controller board can drive both an analog monochrome monitor and an RGB color display.

The machine supports block graphics and multi-colored text with the optional color display. Each character consists of two bytes of information. The first byte is the character's ASCII code; the second, its display information, with each bit representing one display attribute. Controls are available for Character Intensity (bits 0 through 2), Character Enable, Reverse, Underscore, Blink, and Alternate-character Set.

To get high-resolution graphics, you have a choice of two raster-graphics cards, both of which mount piggy-back onto the video display card. The first is a simple two-color card—black and one of eight colors. The other is an eight-color board. As with the conventional display, the high-resolution graphics screen is 720x300. Both cards allow pixel control of the screen matrix, and both let you mix

text and graphics. They differ in price by about \$135, and the two-color board cannot be upgraded.

For the time being, additional hardware options are available only from Texas Instruments, but what exists should be sufficient. They offer a Winchester hard-disk drive, available with either a TI or a Seagate logo, whose controller card can direct the operation of the device and even perform a self-test. The RS-232 card is configurable as either asynchronous or synchronous, with baud rates up to 19.2 kilobits per second. In synchronous mode, you can use either synchronous data-link control (SDLC) or high-level data-link control (HDLC).

If you prefer communications over serial printing, and you prefer not to have an external modem, the Professional has space for an internally mounted modem. It can auto-dial, auto-answer, and operate in either originate (send) or answer (receive) modes. Transmission speeds are 300 or 1,200 baud, with synchronous communication possible at 1,200 baud.

The favored operating system, a variation on MS-DOS from Microsoft, is available at extra cost. Included with it is MS-BASIC, which has been slightly altered to work with the Professional. As with all versions, the BASIC editor is superb. There is no need for an editing mode, per se, since the editor is screen-oriented and is in residence at all times.

To change a program line, you list the line number, advance the cursor to the portion you want to change, and edit as needed, using the Insert or Delete keys. It's that simple.

The Get and Put commands deserve special attention. By using Get—a predefined array—and specifying coordinates, you can identify and store a section of the graphics screen. Once retained in the array, you can place the image anywhere on the screen by using the Put command. Of course, working with graphics on the Professional is somewhat simplified because it has only a high-resolution mode.

Many outside vendors, as well as TI itself, have been producing software for the Professional. There's the expected complement of applications packages—*dBASE II*, *Visicalc*, *WordStar*, *1-2-3*, *Easywriter II*—and scores of others. However, these do not include software written for the IBM PC. Indeed, the Professional is almost PC incompatible. The only language it understands is *Microsoft BASIC*. And even then, some BASIC programs for the PC will not run on the Professional. This is particularly surprising because both machines use Intel's 8088 microprocessor—and particularly annoying, because it eliminates thousands of programs that would otherwise be there for the taking.

If you select the 8087 math processor as an option, TI can provide *MS-FORTRAN*, *MS-Pascal*, and *MS-COBOL*, all of which support it. TI itself refers to both the 8088 and 8087 as the processing section of the machine.

The manuals for the computer and MS-DOS are uniformly excellent and are replete with informative examples. They presume little previous computer knowledge on the part of the user and are handsome, sturdy, and, as professional as the Professional itself.

There are very few real complaints to be made about the TI Professional Computer. It is certainly not perfect, but that's not to say it isn't very good. It is a minor annoyance, for instance, that you need two add-on cards to bring the machine up to its full complement of memory. The IBM PC and many other clones provide 256K on board.

It is more irksome that the expansion slots on the Professional are *not* the same size as those on the IBM PC. Until other aftermarket manufacturers provide plug-in boards for the machine, TI will be the only source. This is not good for either the consumer or the company. It's surprising that the designers didn't think to tap into the burgeoning market of multifunction paraphernalia—as well as software—available for the IBM PC. Rather, it appears that TI combined some IBM, some Apple, and some home-grown schemes in the hopes of developing a computer with mass appeal. They may have found a winner.

Texas Instruments, Inc., \$2,195 (base price)

TRS-80 MODEL 12/16B

A computer's lineage can be a fairly important factor; it bodes well, for example, if a machine can run software designed for earlier computers made by the same company. Not only will there always be plenty of available software, but you can safely assume that you won't be left high and dry when a new "improved" model comes out. Such is the case with the TRS-80 Models 12 and 16. Their pedigrees are impeccable.

The father of the line is the Model II. The Model 16, which incorporated the Model II's Motorola 68000 16-bit microprocessor and the 8-bit Zilog Z-80, while adding several design improvements, was next, and the Model 12 followed roughly a year later. Essentially a refined version of the Model 16, the 12 also offered the 68000 processor as an option. From this, the Model 16B was born; it combined all of the features and improvements of the 12 and the 16, and still maintained considerable software compatibility with the now ancient Model

II. Sound confusing? It is, but Tandy has a method to its numerical madness.

This family of computers is aimed squarely at the business user and must be considered a serious contender in that class. Models 16, 12, and 16B may also be of interest to anyone engaged in software development, since a variety of compiler languages and utilities are available for all three.

The Model II was the inspiration for the Model 16. Both are about the same size, with detachable keyboard, 12-inch display, 8-inch disk drives, and the Z-80 processor. The 16, however, added the 68000 processor, some board slots for expansion, a green screen, and space for two thin-line double-sided drives with 2.5 megabytes total capacity. The II could accommodate one drive of 0.5 meg. The Model 16 came with the Xenix disk-operating system, Microsoft's version of Unix, as well as several versions of Radio Shack's TRSDOS.

The Model 16 is no longer in production, but its sibling, the Model 12, is. The Model 12 is an even better business machine than either the II or the 16. It is especially worthwhile for single-user applications that may later expand to multiuser operations or may require networking of several computers or terminals.

The Model 12 hardware was designed with an eye to future expansion. The base model is supplied with 80K of RAM and the 8-bit Z-80A microprocessor operating at 4 MHz. An optional internal card cage provides six plug-in card slots that can be used to add a 16-bit MC68000 processor operating at 6 MHz, RAM memory to 768K, and Arcnet networking board, and a high-resolution graphics board.

The 12-inch high-resolution green-phosphor display monitor and either one or two double-sided double-density disk drives of 1.25 megabytes in the main unit are attached by cable to the separate keyboard. Both units are a pleasant buff color.

You can add two more external floppy drives of the same capacity. They are available in a matching case that will power and hold one or two thin-line drives. You can also add up to four 12-megabyte hard-disk drives. In addition to the connections for the external drives, two serial (RS-232C) ports and a Centronics-type parallel port are standard.

The 82-key keyboard includes Hold, Escape, Control, Break, Caps, Repeat, and eight programmable special-function keys positioned around the numeric keypad. The keyboard has a nice feel and can be set to provide an audible to somewhat loud cue to action.

The power on and reset keys are located just to the right of the display on the main body of the

machine; small red lights indicate whether the unit is on or off. The disk drives have similar lights that signal whether the disk drive is being accessed. These drives do not run continuously as did the Model II's. Because of this, with the 12 operating system all Model II software requires a patch supplied with the 12's operating system, before they can be run on the 12.

The general arrangement and appearance of the Model 16B is identical to that of the Model 12. Internally, however, the 16B sports a 6-MHz MC68000 processor, and 256K of RAM (expandable to 768K), and four open card slots for additional expansion. The machine is available in three configurations: one internal disk drive (same capacity as Model 12); two internal disk drives; or one internal floppy-disk drive and one internal 15-megabyte hard disk. You can add up to two external floppies or four 15-Meg hard-disk drives (except for the model with the built-in hard disk, which can take only one more hard disk).

The TRS-XENIX operating system supports multi-user operations and several users working from a low-cost DT-1 data terminal.

Radio Shack supplies with the machine four different disk operating systems. This allows users to run Model II software, new Radio Shack Z-80 programs, CP/M (Z-80) software, or MC68000 16-bit software.

TRSDOS 2.0 runs Model II software, but in a mode using only one side of the double-sided diskettes, thus limiting external storage.

TRSDOS II runs some Model II software in a mode that uses both sides of the diskettes, thus making their full storage capacity available.

TRSDOS 16 uses the 68000 microprocessor for operations.

CP/M Plus for the Model 12/16 will be available by the time this is printed. Several third party suppliers also supply versions of CP/M for the Model 12.

Finally, a hard-disk version of the 16-bit Xenix operating system, which is Microsoft's implementation of the Bell's Unix system, is also included. A floppy-disk version is rumored to be forthcoming.

By adding useful commands, utilities, and features, some of the problems and deficiencies of the earlier disk operating systems have been corrected. In some operations, however, the new disk operating systems are painfully slow, and corrections have been slow in coming out. In addition, many users like to use the *Profile* database manager in tandem with the *Scriptit* word processor. But whereas the *Profile* works under TRSDOS II in the double-sided mode, the available *Scriptit* ver-

sion doesn't; it runs only with TRSDOS 2.0. To use this combination you must drop the *Profile* to the 2.0 level and lose the disk storage capacity. Eventually, Radio Shack will make all of the popular software compatible with TRSDOS II, but until then, there will be inconveniences. TRSDOS 16 is fine, but there isn't much software available for it yet.

Trying to maintain compatibility among different generations of computers by offering a wide variety of disk operating systems is commendable, but it has caused some problems. For one, the commands among the several systems are not identical, which can be annoying. Also, TRSDOS 2.0 and II are better disk operating systems than CP/M, but both require the user to learn and remember many commands, and either one may not run the specific software desired. Finally, an advance microprocessor like the MC68000 is useless for anything but software development until there is software to run on it.

There is yet another disk operating system, CP/M 68K, available from other sources for the Model 16/16B. It runs in conjunction with CP/M 2.2 and permits switching between the two. A 68000 assembler and a C compiler are provided.

The 8-bit software picture is generally good. Radio Shack has a substantial reservoir of programs oriented to TRSDOS, and the company is releasing an increasing number of popular programs, originated for other machines: *VisiCalc*, *Multiplan*, and others. The Radio Shack catalog includes a variety of accounting and professional packages, and if you get the optional CP/M Plus, a huge array of software becomes available.

Applications software for the 16-bit mode is still relatively scarce but should improve shortly.

Software developers will be pleased with the number of programming languages available for the TRS-80 machines. For the 12, BASIC, FORTRAN, Pascal, Assembly, and COBOL are available, as is CBASIC for CP/M. For the 16, there is a COBOL development system for TRSDOS 16 and one for TRS-Xenix. There is also a TRS-Xenix development system that includes a C language compiler, and an optional TRS-Xenix BASIC interpreter is also available.

In summary, the 12 or 16B should be considered by business users whose needs may expand and change and who want to avoid having to discard a system and start over. This is especially true for those who presently require only a single-user system, but who may eventually need multiple stations. This potential expandability is these computer's biggest asset. In fact, by the time you

reach the limits of growth on any of these machines, the whole computer state of the art will likely have changed anyway.

Radio Shack, One disk Model 12 \$2,799; Two disk Model 12 \$3,499; card cage \$199; 68000 + 128K RAM \$899; 64K RAM \$399; One disk Model 16B (256K) \$3,999; Two disk Model 16B (256K) \$4,699; Model 16B with hard disk \$6,499; 15 Meg hard disk \$2,495; 128K Memory board \$399; 128K memory kit \$159; Thinline floppy expansion: One drive \$1,299; Two drive \$2,098; 15 Meg hard disk (1st) \$2,990; 15 Meg hard disk (additional) \$1,995; Hi-Res graphics \$499; DT-1 Data Terminal \$699

VECTRIX VX128/VX384 GRAPHICS SYSTEM

If you've never seen a high-resolution RGB (red-green-blue) display of computer graphics before, hang onto your hat! This is not just television stretched to its limits, it's video images in another dimension: clear, sharp, unwavering, and oh, what colors!

This is what you can expect from the Vectrix graphics systems. The Vectrix is not quite a stand-alone computer; yet it is far more than an add-on. For relatively simple graphics operations, the Vectrix has its own keyboard. In normal use, however, it is hooked to almost any computer through a printer port. The main computer then does all the number crunching and outputs graphics instructions as though to a printer. This lets the main computer do what it does best—standard data processing—rather than burdening it with display duties.

Based on the 8088 microprocessor, these highly specialized computers offer extremely high resolution—672 pixels horizontally by 460 vertically—and gorgeous color. The VX128, with 128K of dedicated graphics RAM, displays eight colors; the VX384, with an extra board and 384K of graphics RAM, displays up to 512 shades simultaneously. Both models can choose from a palette of 16.8 million colors.

It would be pointless to give such resolution, then try to display it on a television, or even on a composite monitor. Vectrix requires an RGB monitor. The firm suggests using their own VXM model, but others will do. The RGB monitor also gives the processor independent control over the red, green, and blue components of the image, yielding a much better display than the conventional TV image, where the color scheme is based on the angle with which a basic carrier signal is modulated.

The idea behind the Vectrix is that the graphics functions have been taken out of the microcomputer and reside in the graphics processor, a frame buffer in which an entirely separate microprocessor memory is devoted to the storage and display of computer graphics images. It is this graphics processor that takes over the display operations from the main computer.

The installation procedure is fairly simple, following the instructions in a clearly-written manual. You first connect the output of the frame buffer to the monitor using special BNC-type connectors, one each for the red, green, and blue signal components and a few others that synchronize the monitor to the frame buffer's clock rate. The monitor then sits conveniently atop the processor.

Next, you connect the processor to your microcomputer. A parallel ribbon cable is preferable, because it makes for faster data communication, but an RS-232 connection is also available. At the other end, the cable is attached to your computer's printer port; as far as the main computer is concerned, the Vectrix is just another printer. If you like, you can also connect a color printer/plotter to the frame buffer.

Under normal circumstances, the commands used to create the graphics on the RGB screen or printer are a simple program in BASIC or another high-level language (Vectrix developed the machine's own software in Digital Research's PL/I-80 before translating it to ASSEMBLER) run on the host computer and sending instructions to the graphics processor using simple LPRINT statements. The commands range from major activities, such as setting whether the system is to operate in 2D or 3D mode, to simple cursor addressing.

A typical command might be:

F448, 4, 236,140, 436,140, 436,340, 236,340

This would create a (F)illed polygon using color 448—blue. The polygon has four vertices, the first address of which is 236x/140y. It would be just as simple to create an unfilled polygon by using "P" in place of the "F."

This means of creating programs for computer graphics images is so simple once you get the hang of it that you soon forget that you are not working with an interactive system and must create each step of the image from scratch. But what power this gives you! Using one-, two-, or at most three-letter commands together with a location value or color you can use just about every algorithm that has yet been devised in both two-dimensional and three-dimensional computer graphics: addressing different bit planes to simulate animation; color map lookup tables; graphics primitives

for circles and arcs, polygons and filled polygons, rectangles, dots, and lines; creation of symbols and character sets together with storage in a pattern register; manipulation of characters for slanting, size, and position; magnification, mirroring, inversion, repetition, perspective, and so on; special commands to create composite video if the image is to be stored and viewed on a regular monitor; instructions for hardcopy printouts; defining viewports and windows; filling and flooding; and so on.

The software is particularly strong for creating three-dimensional images, and many of the functions above work in both two- and three-dimensional modes; 3-D operation requires entering three axis points instead of just two. In 3-D, edge clipping is performed automatically; when the 3-D wireframe shape is created, areas of the image falling outside the viewing plane are eliminated. Since the points entered when creating a 3-D program represent locations on the object plane rather than the viewing plane, the system can also perform myriad other 3-D processing, including three-dimensional scaling and rotation.

What's really amazing about the Vectrix system is that it is truly easy to use, even if you have very little experience with BASIC programming. You will have to learn the simplest rules of program writing, and you must also learn to compile a program. Compilation is covered in the BASIC manual; simple programming is covered in the Vectrix manual.

The manual also includes a tutorial that takes you through the basic principles of the system. In general, it is well written. However, the many updates made to the system since it was first released are bound together as errata pages. The notice, "Incorrect: Please see the errata sheets following" appears far too often in the main text. Someone at Vectrix ought to do a proper update of the manual and store the result as word processor files for easy revision.

This is plainly not a system for amateurs who want to play casually with graphics. Its price tag alone, over \$5,000 with the monitor, should indicate that it is meant strictly for professionals who take their computer graphics seriously. Nor does the thought of having to program the system in BASIC, ASSEMBLER, or another programming language appeal to everyone; many would rather invest in an interactive program in which all the choices have been made in advance.

The Vectrix system is, however, an extremely powerful tool and one that professionals should find more than adequate. It is also a system that will continue to grow. New programs are added

frequently, often with low-cost updates for current users.

Vectrix Corp., VX128 processor \$3,295; VX384 processor \$4,995; VXM RGB monitor \$1,995 when purchased with either processor; Color graphics printer \$1,295

WANG PROFESSIONAL COMPUTER

The Wang Professional Computer will appeal to several obvious markets: It is a wonderful choice for someone who already owns Wang OIS or Alliance word processing or a VS system; for a bit more than the cost of a workstation, you can buy both a workstation and a top-quality personal computer. For any office, it's attractive—a completely menu-driven system with excellent word processing and communications. Even for programmers with no other Wang equipment to worry about, it is a reliable, well-supported computer. But if you want to hook up a videodisk, process speech, or control a coffee maker, you had best look elsewhere.

The basic Wang PC comes in two boxes: a keyboard and an electronics unit. The keyboard has 101 sculpted keys, and it's probably the best available on a personal computer. Modeled on Wang's word processing keyboards, it provides a standard typewriter layout, a diamond of cursor control keys, a separate numeric keypad, a top row of 16 special function keys, and various editing keys. The function keys are marked with word processing commands and function numbers, and there is an indentation below the special function keys for a customized label strip. There are five programmable LEDs under the function keys and a sixth that indicates whether you've hit the shift lock.

Attached to the keyboard is a two-inch speaker that can generate up to three tones and noise simultaneously. The speaker emits a click to confirm each keystroke. You may not appreciate this feature, so the operating system includes a utility to turn it off.

The electronics unit is roughly 14 inches by 23 inches by 7 inches and weighs 30 pounds. It is bulkier than competing machines, but it can sit flat or upright, or can be clamped to the side of a desk. (The introductory guide that comes with the machine devotes four pages of drawings and tables to answering the question "Will Wang's clamp work on my desk?") The standard electronics unit has space for five boards in addition to the system board, and a new expanded-chassis model—two inches wider—offers three more slots.

The machine is based on Intel's 8086—ads call it

"a true 16 bit microprocessor"—running at 8 MHz. The high clock speed and more powerful processor does give significantly faster response than on the 4.77 MHz, 8088-based IBM PC. There's a socket for an 8087 numeric coprocessor, which performs some mathematical calculations up to 50 times as fast as the 8086 itself. However, you'll have to find one that runs at 8 MHz; they are rare and costly. The system arrives with 128KB of memory, one RS-232C serial port, one Centronics parallel port, and one 5¼-inch 360KB, double-sided floppy disk drive. There is room for either a second floppy drive or Wang's 10MB Winchester drive.

One of the system's expansion slots will have to hold a monitor card. Wang offers two choices. You can buy a single card to be used with either an "industry-standard" monitor or a television set. This board handles characters and offers two graphics formats: 640 by 256 pixels in four colors or 320 by 225 pixels in 16 colors. Or you can buy a character card for their 12-inch green-screen monitor and optionally add a graphics card that gives 800-by-300 pixel resolution.

Their monitor gives sharp, clear characters in a matrix of 10 by 12 pixels. It displays Wang's 256-character WISCII (Wang International Standard Code) party hardware for the additional slots. Wang is extremely close-mouthed about their system's internals; nothing about the expansion slots or system bus appears in the Technical Reference Manual. PC owners must wait for Wang to build the clock/calendars, graphics enhancements, and bizarre disk controllers available to owners of other systems. Wang does, however, offer a fairly wide range of their own options. Memory is expandable to 640KB with 128K, 256K, and 512K cards. Another card adds three RS-232C serial ports. There's a CP/M-80 emulation card. The hard-disk controller will run a 5¼-inch, 10MB Winchester.

These computers specialize in communications. Wang wrote software to make the serial card emulate several IBM terminals. Another card ties PCs into a local area network. With the right software, one card will turn the PC into a Wang VS remote workstation. Others allow the PC to function as a VS, OIS, or Alliance workstation, though you can't download files from the PC in this emulation. The same cards let the PC store data in the VS or OIS systems like just another disk drive; you can keep your files on your OIS system, and your PCs can work with them from there. Atop this mountain of enhancements stands Wang's Professional Image Computer, which scans, labels, stores, retrieves, communicates, and word-processes pictures.

The Wang PC comes with Wang's version of the

MSDOS 2.0 operating system, BASIC, and diagnostics. When you turn on the PC, you find a completely menu-driven machine. The menus lead you to many of Wang's core software products—word processing, BASIC, *Multiplan*, communications—to the systems utilities, and even to a program that allows you to add and edit menus as you buy more software. If you tire of groping through menus to get to what you want to do, the Introductory Guide shows you how to set the system to come up with the DOS command processor.

The menu system is great for novices; you can get right into your word processing by just picking "Applications" then "Word processing" and replacing the system disk with the word processing disk. In systems without a hard disk, the ease of menus is compromised by constantly having to change disks. You quickly learn what to do when you see "Sorry, Program A:WP.EXE Not Found" and "Sorry, Unable to Run Program A:MENUCOM."

Wang divides its software catalog into three parts: core products they have tailored to their system which they sell and support, distributed products that meet Wang's software standards, which they sell with support from the developer, and evaluated software, which they're happy to tell you about.

Leading off for the core group is Wang's word processing, as good as the systems found on their dedicated word processors. Then they offer Microsoft's *Multiplan* and Microsoft *Windows*. They offer *PC Business Graphics* by Business and Professional Software. They've written their own *PC Data Base*. They support BASIC, PASCAL, FORTRAN, and COBOL compilers. They've got a UCSD-p system from Softech and *Micro Focus's Level II COBOL* environment. And there's the CP/M-80 emulator and communications software mentioned above.

Wang offers hotline numbers, on-site and mail-in maintenance, and an aggressive sales staff. The documentation for setting up the system and using their core products is excellent, with lots of drawings and pictures of the menu screens, step by step instructions, and a glossary.

You get a variety of MSDOS utilities with the PC, several tailored to fit Wang's menu system. The system makes sure you get prompted by menus when you invoke a utility from a menu; you don't get menus when you're using the DOS command processor. Wang includes some extra utilities for converting documents for the word processing package back and forth from ordinary text files (word processing documents are full of formatting

codes), and for setting the speed and parity of the serial port. At least some releases of the operating system omit EXE2BIN or RESTORE. You receive the assembler, debugger, linker, and library manager when you buy any of the core compilers.

Early releases of the operating system had some problems with the printer drivers; these have now been cleared up. A new utility lets you set the escape sequences used for negative line feeds, bold-face printing, and similar format features. It also lets you request character translations and tell the driver whether to look for such things as lines that get too long. You can even tell the system to pass everything to the printer as-is. New releases of the operating system also add disk emulation, a marked asset.

The advanced documentation is not as good as the introductory guides. The Program Development Guide and the Technical Reference manual could use better indices, and they could be more informative. For example, the BASIC documentation talks about assembly language subroutines but doesn't tell how to load them. The 2ND key is logical but undocumented; users looking for backslashes or vertical lines, for example, must discover by trial and error that they come from 2ND-/ and 2ND-!. BIOS documentation talks about "invisible" keystrokes but doesn't tell how to make them visible. And there's more in the MS-DOS program segment header than they're telling.

Of course, that is more than most Wang users will ever need to know. Wang does not mean this to be a hacker's machine, but a productive office model. For that purpose, the company sells a great computer. They're constantly adding new features. Their software is well-designed. An experienced programmer may have to learn patience, but a novice can set up the Wang PC and use it effectively from the first day.

Wang Laboratories, Single-disk system without monitor \$2,595, with monitor \$4,030; Dual-disk system with monitor \$3,790; Hard-disk system \$6,400; 128KB memory expansion card \$510; Local communications option for attachment to OIS, Alliance, or VS, \$2,000; CP/M-80 emulation \$600; Software productivity package with word processing, *Multiplan*, asynchronous communications, \$650

XEROX 16/8

At about the time the IBM PC made its first appearance, another giant of the office-products industry was bringing its first microcomputer to market. As it turned out, the prominence of the companies was the only similarity between the two

debuts. The Xerox 820 and the revised 820-II were two of the least successful computers brought out that year. With the arrival of 16-bit computers, these simple—and somewhat overpriced—CP/M machines had become obsolete before leaving the XEROX design shops.

XEROX's 16/8 is the company's attempt to bounce back from this unpromising beginning. It is an uncommonly versatile microcomputer, but it also has several strikes against it.

The 16/8's chief advantage over the competition is that it has two central processing units instead of one. A Z-80 running at 4MHz handles 8-bit software while an 8-MHz 8086 runs 16-bit programs. Each CPU is outfitted with its own independent memory, making the processing system exceptionally fast.

The basic 16/8 system, built into a terminal, includes a keyboard, the monitor, and 128K of working memory, expandable to 256K. Also standard, but priced separately, is a pair of 8-inch disk drives. Two 5¼-inch drives and a 10 megabyte hard disk are also available.

The keyboard is a new design for the 16/8. The 820 came out originally with a high-profile keyboard; it was so poorly received that it was replaced in 1983 with a slimmer keyboard. The keys of that board were excessively stiff, however, and customers resisted it as determinedly as it resisted them. The newer low-profile keyboard has a good touch and is virtually silent. It is well laid out. There is a control key on either side of the space bar. Twelve function keys are arrayed across the top, a block of keys for PREV and NEXT (used with *WordStar*, they shift the text one screen at a time; in *dBASE II*, they move one record forward or back in the file) DELETE and ACCESS—a variant of RETURN—a calculator-style numeric keypad, and several keys whose functions may be assigned by software.

All this is reasonably close to standard. What's novel about the 16/8 is its operating systems; there are three of them. The first is a fast version of CP/M-80 known as 820-II mode; it emulates the 16/8's 8-bit ancestor. The second operating system combines CP/M-80 and CP/M-86, running both 8- and 16-bit programs independently. The third is MS-DOS, the generic version of the IBM-PC operating system. Supplying all three systems gives this computer access to a tremendous range of applications programs.

Running anything but the 820-II mode operating system is slightly cumbersome at present. The 820-II software must be booted up first, even when you plan to run one of the other operating systems. A

command then allows you to load the co-processing versions of CP/M-80 and CP/M-86, which are stored as standard disk files rather than as functional operating systems. Or you can boot up MS-DOS instead; partway through the process, the computer will prompt you to put MS-DOS formatted disks into the drives, as it can no longer read CP/M disks. Once loaded, it works as it does on other computers. According to the company, the MS-DOS and co-processing CP/M operating systems are being revised to eliminate disk changes during loading.

The co-processing mode is the most interesting of these options. I/O for both processors is handled by the Z-80. It seems that this should slow the system considerably, but Xerox cites a test at the University of Texas that reported this to be among the fastest computers studied, save in procedures where some others resorted to an 8087 math co-processor. In use, this was not formally checked, but no undue delays were noted.

When both 8- and 16-bit programs are run, only one is on the screen at a given moment. There is no provision for windowing. However, either program can be called to the screen with a single keystroke: CONTROL-RETURN brings the 16-bit program up, while CONTROL-BACK switches the screen to 8-bit processing. Rebooting returns the system to 820-II mode.

A utility helps to integrate these separate modes. The command READ CP/M transfers CP/M files to MS-DOS; a program to convert MS-DOS files to CP/M should be available by the time this appears. Another utility makes it possible to tinker with operating system variables that govern the disk drives and other hardware.

In the last decade or so, Xerox has made a major effort to develop a practical local area network (LAN) system, a way to transfer data between computers by cable at high speed. The result, known as Ethernet, is a costly LAN, but a fast and widely accepted one. An accessory to the 16/8, the Shared Interface Unit, can link this computer into an Ethernet system with other Xerox products. By the end of 1984, an adapter to link IBM PCs into the LAN should be on the market as well.

Other accessories for the 16/8 include a series of expansion boxes. These will accommodate either five or ten add-on boards, depending on the model. They are available with or without 5¼-inch disk drives, and a 10-Mb hard disk is soon to be released. Unfortunately, these expanders use the Mostek 50-pin bus, a relatively uncommon design, and the selection of boards available to fit them is relatively limited.

In all, this machine is sturdy, reliable, and versatile. Its co-processing capability offers unusual technical opportunities for anyone developing software for in-house use. The ease of linking it with the Ethernet LAN system will be a convenience to companies that already use Xerox computers or word processors, and at less than \$1,000 an upgrade kit for the 820 and 820-II computers represents a considerable saving for users of the earlier Xerox machines.

This is clearly a transitional model, however. It manages to link CP/M and MS-DOS, but in a way that is relatively clumsy to use. While some refinement of software is due, a major development effort is unlikely. Xerox sees the 16/8 as the last of its line. A new series of computers is planned for no later than the first half of 1985. That may well put off some potential 16/8 buyers.

Another disadvantage is price. At under \$2,350, the 16/8 sounds competitive, but this price includes only the processor, monitor, and keyboard. Disk drives are extra. When these are added in, 16/8 systems cost more than many others, and they are less likely to be discounted.

When all these factors are considered, it becomes difficult to recommend the 16/8 to anyone who does not already own Xerox equipment.

Xerox Corporation, System unit \$2,245; Dual 5¼-inch disk drives \$1,200; Dual 8-inch disk drives \$2,200; 10-Mb hard disk \$3,050

ZENITH Z-100

Zenith refers to its new computers as the Z-100 series. On the market for more than a year, the series offers some sophisticated features at reasonable prices.

The Z-100 is built around twin microprocessors to permit the use of both 8- and 16-bit software. In this it closely resembles the up-market CompuPro 816, a highly rated system said to have inspired the Z-100's design. Like the 816, the Z-100 series uses both an 8088 processor and an 8085. The 8088 runs the newer 16-bit application software; the 8085 runs 8-bit software. The clock speed of both is 5 megaHertz. This means the new user can continue to work with older, slower software after buying the machine—and also add the new bigger and faster 16-bit software now becoming available. Since the Z-100 is available with CP/M, there are more than 10,000 existing 8-bit CP/M software programs that can be run with little or no alteration.

You get both CP/M and the Microsoft ZDOS operating system. A recent survey indicates that there are more than 100 programs in ZDOS—so that be-

tween CP/M and ZDOS, the Z-100 owner has a wide variety of applications software to choose from. Note that the Z-100 is not rated as compatible with the IBM PC and very few IBM programs will run on it out of the package.

Bigger RAM (random access memory) is the hallmark of computers now arriving at dealers, and the Z-100 is no exception. It comes with a standard 128K RAM; another 64K can be added to the mother board at additional cost, and then other boards can be plugged in to bring the total to 768K.

Two configurations are available: an all-in-one model, with built-in 12-inch green video display and attached keyboard, or a low-profile model, with the CPU and disc drives in a low cabinet with attached keyboard, for use with a detached monitor, either color or B&W.

Oriented around the standard S-100 bus, the Z-100 has good expandability. There are four open card slots for adding memory and peripheral devices. The computer comes with two serial and one parallel port. The parallel port is Centronics compatible, and the following printers are compatible with the Z-100 (hardware and software supported): Zenith-Heath Z-25 and Z-125; Diablo models 630, 1610, 1620, 1640, and 1650; Epson MX80; DEC LA34 and LA36; Texas Instruments T1810; and Heath 114.

The Z-100 keyboard has a good substantial touch, the kind that lends itself to fast, accurate typing. Twelve special function keys are arranged across the top of the keyboard. They are convenient, but if you are accustomed to the IBM PC's cluster of special function keys at the left side of the keyboard, you'll need a few days to get used to this arrangement. The cursor control keys are at the top of the numeric keypad at the right side of the board. Special insert and delete keys are provided for text editing.

Z-100 models come with one or two floppy-disk drives built in. The floppies are 5¼-inch, double-sided, double-density types with 320K bytes per disk. Hard-disk drives can be had in both the all-in-one and low-profile units. These have 192K of internal memory, a single 320K floppy disk, and an 11.3 megabyte built-in hard disk. The Z-100's disk controller is one of the machine's most sophisticated and useful features. Though the computer is supplied with 5¼-inch drives, the controller also can operate 8-inch drives. Virtually all CP/M software produced is available on 8-inch disks, and data files from any 8-inch CP/M system can be transferred to any other system using a standard single-sided, single-density format. Few other computers that use 5¼-inch drives offer this added compati-

bility. Zenith does provide single- and dual-drive 8-inch subsystems, but they are priced considerably higher than equivalent units from other vendors.

When shopping for a Z-100, check on whether or not the model you are interested in has built-in color capability. In some models it is standard, and in others, another board must be added. Models that do not have color require the addition of two RAM chip sets. To add color later costs considerably more than buying it built-in at the start.

The Z-100 is solidly built, with good service available in most areas. In some places, on-site service via radio-dispatched trucks can be had in as little as four hours. Carry-in service is available at Zenith dealers and also at all Heathkit stores. Because of modular, plug-in component construction, service usually is easy and fast.

Zenith Z-100 and Z-150 computers also are available in kit form from Heathkit at considerable savings. For example, the Z-100 with two disc drives lists at \$2,449 in kit form, a savings of \$1,000.

Zenith, Low-profile version with monochrome board \$3,029; All-in-one Z-100 with 12-inch green monitor, 128K RAM, and two disk drives \$3,599; with color graphics board \$3,499; All-in-one model with 192K RAM and 11 MB hard disk-drive \$5,599; Low-profile model with hard disk and color graphics \$5,499; Single 8-inch disk drive \$1,599; Dual-disk 8-inch subsystem \$2,299.

ZENITH Z-150

Zenith Data Systems engineers, using the 8088 CPU microchip and the MS-DOS operating system, set out to design a computer that would run the great mass of IBM PC applications software straight out of the box. With the Z-150, they succeeded. Computer buyers who have been burned by listening to claims of compatibility with the IBM PC, only to learn that most IBM software won't actually run on their machines, will find the Z-150 refreshingly different. *Lotus 1-2-3*, Microsoft *Flight Simulator*, and *Xeno-Copy*, all programs noted as tough tests of compatibility, run as-is on the Z-150. In addition, Zenith has a list of over 175 other programs that have run successfully without modification. It appears that only programs written in *GW BASIC* and *BASICA* won't work.

The Z-150, however, is not a copy of the IBM PC but an advancement in that design. Working within the constraints of IBM architecture, Zenith has been able to make some major improvements, most of which add up to greater speed of operation.

The IBM, for example, has one slow software scrolling mode, which can be a headache, as those who use *WordStar* on the PC have learned. The Z-150 has five scrolling modes, backed by improved algorithms, which make the machine faster. In smooth scroll, the Z-150 is two-and-a-half times faster than the IBM. The diagnostics on power-up in the IBM take about a minute to execute; the Z-150 does the job in three seconds.

Aside from its IBM compatibility, perhaps the greatest attraction in the Z-150 is the upgrade concept employed in its design. The machine is a bus-oriented system using four boards: A CPU board, a video board, an I/O board, and a disk controller board. The bus-oriented structure permits instant replacement of the boards in order to upgrade the machine.

Replacement of boards, of course, isn't unusual. But the ability to do more than just add RAM is. With the Z-100, the user will at a later date, be able to upgrade, from the 8088 CPU to the bigger, faster 80186 or 80286 CPUs, and move up from a clock speed of four megahertz to eight megahertz, simply by replacing the CPU board. Most important is that the upgrade won't require an additional power supply or other outboard equipment, thus keeping costs relatively low.

This solves a problem people who have had computers for two years or more are beginning to discover: when it comes time to take advantage of the new speed, size, and other bells and whistles that have been added to micros in the past couple of years, they must start over. The old computer has to be donated to a worthy charity because there isn't much that can be salvaged.

The Z-150 owner, however, won't have to scrap his system in a year or two to take advantage of the more muscular software programs now on the drawing boards. Instead, he will install a new board or two and be ready to run with the leaders of the pack.

Upgrading in this sense is like pulling the four-cylinder engine out of your car and plugging in a new eight-cylinder power plant. For immediate expansion, four open IBM-compatible slots are provided in the Z-150. If you add a hard disk, one of these slots will be used, but three still remain for the addition of peripherals.

The Z-150 is delivered with 128K of RAM. This can be expanded to 320K on the main board and to 640K with the addition of another board. But note that the machine is ready for the new 256K chips when they become available. This means that in the future you can expect to put 640K of memory on one board.

Single or dual disk drives are available, storing 360K bytes per drive and using the standard IBM double-sided, double-density format. Also available is a built-in 5¼-inch Winchester hard disk providing 10.6 megabytes of storage. The Z-150 Winchester can support up to four hard drives, but additional units will have to be set up along side of the Z-150. Keep in mind, though, that MS DOS address spaces are limited to eight megabytes; having a huge storage capacity is one thing, but using it is quite another.

For connecting peripherals, the Z-150 has two standard serial ports and one Centronics-compatible parallel printer port already in place. No need to spend money on more boards when you add peripherals.

Also, both monochrome and color capabilities are already built into the system, so whether you run in monochrome or color depends on the monitor you buy, and not on whether you have the right video board. And you won't have to buy a new board if you decide to upgrade from monochrome to color. Zenith expects to market a high-density video board for operating a high-resolution (640 by 225) monitor in the next few months. This will permit very sophisticated graphics and the use of such software as the Tektron Graphics Emulation packages.

If you choose to go monochrome, you can opt for either an amber or green phosphor monitor. Most people who spend long hours at the computer claim the amber is easier on the eyes.

The keyboard of the Z-150 is detached, which most users feel is an advantage. It comes with a 3-foot coiled cord which expands to 6 feet. But since it comes out of the back of the unit, you can move only about 4.5 feet from the computer while working. If you are one of those who likes to type with the keyboard in your lap, you have enough room to do it.

The keyboard is electronic rather than mechanical and thus weighs only 3.5 pounds—about half the weight of IBM's keyboard. It has a nice solid touch.

More important, it has been laid out to suit the flying fingers of a touch typist. The return key is where a touch typist would expect it to be and is double-sized. The shift keys are also double size. The back slash key no longer accidentally gets hit when you mean to type Return, as it does in the

IBM. A nice touch is the audible feedback that allows you to hear the spacing when you hold a key down for repeat. To help quicken the operation of the Z-150, there is a rate advance, which speeds up the cursor as it moves on longer runs.

Two other nice touches: You can boot up from either drive, a timesaving feature, and you can choose from four display type styles.

The computer box is small, 16 inches by 16 inches, and takes up a minimum of desk space. The box is 6¼ inches high, and the monitor can be used on top of it or to one side, depending on your preference. The keyboard is actually a couple of inches wider than the CPU box.

The Z-150 appears to be a high-quality, ruggedly built machine that should stand up under heavy usage. Zenith's people say it was built with the business environment in mind, which means they expect it to withstand fairly heavy daily usage.

Printer compatibility has been a problem for micro buyers in the past. Printers compatible with the Z-150 and supported by both hardware and software include the Zenith/Heath Z-25 and Z-125; the Diablo Models 630, 1610, 1640 and 1650; the Epson MX80; the DEC LA34 and LA36, the Texas Instruments TI810, and the Heath H14.

Service is made easier by the fact that components are plug-in and allow replacement in minutes. And Zenith maintains a hotline telephone service for technical assistance.

Service for this equipment is generally good, but the time required may depend on where you are located. In some major cities, like Chicago, you can get service in less than four hours from radio-dispatched service units operated by independent contractors. In about 150 locations around the country, good quick service is available at Heathkit stores on a carry-in basis. In other areas, service depends on the local dealer, who may have to ship the machine to a service location—meaning a wait of several days or a week. The service record of earlier Zenith computers has been excellent, with owners generally reporting few calls. Those we talked to personally had averaged a call a year or less.

Zenith Data Systems, \$2,699 with one disk drive, \$3,099 with two disk drives, \$4,699 with 10.6MB hard disk

LUXURY MODELS OVER \$3,500

COMPUPRO 816 SERIES

If you could have any microcomputer system you wanted, what would it be? Maybe a memory-packed IBM PC with all the accessories? Or a Sage with the super-fast 68K processor and a 20-MB hard disk? Perhaps, if you travel a lot, a Grid Systems Compass with its add-on disk-drive unit for your desk at home? For a large and growing group of software developers, systems integrators, plain hackers, and others who require the best, there is only one possible choice: CompuPro's 816 series.

The reason dates from the early days of the microcomputer revolution. CompuPro got its start as a maker of S-100 boards and board kits for quality-loving hobbyists back in the days when an 8K memory card was the state of the art. When the Institute for Electrical and Electronics Engineers got around to formulating a standard for the S-100 bus, CompuPro president Mark Garetz headed the committee that wrote the final report. So unlike most other computer makers, CompuPro still builds its systems around the S-100 bus. It gives them a flexibility that no single-board computer—nor even other bus-structured machines—can match.

The company sells its assembled 816 systems with any of three CPU boards, one carrying both 8085 and 8088 processors, one with an 8086 and room for an 8087 math coprocessor, and the third with a 68000 chip; but a Z-80 board is also available, and 80186 and 80286 processor cards are in the final stages of testing. Though CP/M and MP/M are the standard operating systems for CompuPro machines, a new video board and Digital Research's Concurrent DOS will even let the 8085/8088 system run programs for the IBM PC. With these S-100 machines, in effect, if you've bought one computer, you've almost bought them all.

The 816s all come in CompuPro's Desktop Enclosure 2, a box 20 inches deep by 18 wide by 7.5 high. Inside is a 20-slot motherboard and an enormous constant-voltage power supply. That power supply is one of the system's best features. Capable of running almost any combination of add-in boards, it is so heavily filtered that nothing short of a direct lightning strike is likely to garble your data, even without an external surge suppressor. At the back of the box are three filtered outlets that allow you to plug in your disk drive subsystem, terminal, and printer or modem and turn them on and off with the computer's main power switch.

Two 8-inch disk drives are contained in a separate box, slightly wider and lower than the main-

frame and 2 feet deep. CompuPro uses the Qume Trak 842s, which yield 2.4 MB of online storage when formatted in 1024-byte sectors. Working with the Disk 1 controller, they provide uncommonly fast data transfer.

Most of the 816s come with CompuPro's CPU 8085/88 processor card. With both the 8085 and the 8088 chips, the 816s can run both 8-bit and 16-bit software. The 8085 can be used at clock speeds of either 6 MHz or 2 MHz—helpful when a slow accessory board is in use or when software has been designed for a slower machine; the 8088 runs at 8 MHz, more than three times as fast as the 8088 in an IBM PC. Thus programs that make heavy use of computation rather than disk access tend to run far faster on the 816s than on other computers with the same processors.

The 816/D is an 8086 machine running at 8 MHz or 10 MHz. Its processor card has a socket for an 8087 math coprocessor chip, which handles number crunching up to 50 times faster than software mathematics. Most 8087s now available slow the processor card to 5 MHz, but even at that this is one of the fastest math machines in the micro world.

The 816/E comes with the CPU 68K, the 68000 processor card. Two versions are available; one runs at 8 MHz, the other at 10 MHz. At these speeds they are something more than half as powerful as a VAX minicomputer. But this system's main advantage is not so much its power as its potential memory. Where the 8085 can handle only 64K of RAM and the 8086 and 8088 are limited to a single megabyte of working memory, the 68000 processor can use up to 16 million bytes, four times as much as an average mainframe. If you can find a use for it. Any 816 system can be turned into a 68K computer by switching the CPU 68K board for the one already in use.

The 816 systems are delivered with a variety of memory and I/O options—the only hardware differences between the various dual-processor models. At the bottom of the line is the 816/A, which comes with 128K of memory and an Interfacer 4 board. The memory can be had either as a pair of 64K RAM 17 boards or as one RAM 21 board. The Interfacer 4 provides five ports, three serial, one parallel, and one Centronics parallel. A fourth serial port, used for the system terminal, is found on the System Support 1 multifunction board, which also provides ROM or RAM sockets, a clock/calendar, interrupt handling, and room for an optional math

processor. This board is used in all the 816 machines.

The 816/B is an entry-level multiuser system. It comes with 256K of memory on 64K RAM 16 cards. Six serial ports are provided, but no parallel ports.

The 816/C is CompuPro's major multiuser system. It comes with 512K of working memory on two RAM 22 cards. Nine serial ports are available on the 816/C, one on the System Support 1 card, the rest on an Interfacer 3; two can be used for synchronous communications.

The 8086-based 816/D also packs two RAM 22 cards, for a total of 512K of workspace. It has both an Interfacer and an Interfacer 4, giving full dozen serial ports and two parallel ports, one of them Centronics compatible.

The 68K machine uses RAM 21s instead of the 22s and comes with 256K of RAM. For I/O, it uses an Interfacer 4 card.

The 816 systems have traditionally been delivered with a fairly comprehensive software package, though the details vary from time to time. The A, B, and C are all supplied with CP/M 2.2, and the B, C, and D come with CP/M-86 and MP/M 8-16. A proprietary version of the multiuser operating system, MP/M 8-16 can run both 8- and 16-bit software. Applications packages include *SuperCalc-86* and, for the A, B, and C, *dBASE II*. Word processors in the package have varied. *WordStar* and *SuperWriter* are past selections, but the final choice, reportedly, will be *WRITE*, a powerful and easy to use program widely publicized by *Byte* columnist Jerry Pournelle, for whom it was written.

The 816/E, in contrast to the Intel-powered systems, offers only CP/M-68K and *mapFORTH*. Software developers working on programs for the 68000 processor will almost surely find it suits their needs; others almost surely will not. Given the firm's commitment to the 8080/8086 family of processors, it seems unlikely that the 816/E will receive the support accorded its siblings.

Two hardware add-ons make the 816 series even more appealing. One is a new mass storage subsystem. Combining an 8-inch floppy disk drive and a 40-MB, it provides all the disk space most users will ever need with high-speed data transfer that can halve the time it takes to update an accounting package or other disk-intensive program. All the 816 systems can be ordered with the hard disk instead of the twin 8-inch floppies.

The other is the M-DRIVE/H, a 512K disk emulator that makes even hard-disk storage seem slow.

Up to eight boards can be used in a single computer system, providing 4 MB of disk storage. Three boards are standard equipment in the 816/D and 816/E. If you have a hard disk, you probably will not need an M-DRIVE/H; if not, when you get the emulator, you'll wonder how you lived without it.

Technical sophistication and versatility are not the CompuPro line's only attractions. Two others are reliability and service. Where most other computer makers give only a 90-day warranty, CompuPro gives a full year. And at an extra cost of \$100 or so per board, the company's "Certified System Component" option offers a 200-hour burn-in and a two-year warranty. CompuPro has also arranged for service by Xerox Americare. For the 68K and large multi-user systems, on-site service within 100 miles of a repair center is free for the life of the warranty. Those more distant can either deliver the machine to a center or pay for on-site repairs. For anyone whose business depends on keeping a computer in operation, these are potent selling points.

Unfortunately, there are some disadvantages as well. One is simple size. No one will ever mistake the 816s for portable computers, nor even for desktop models. You'll need a separate stand.

Then there is price. The bottom-of-the-line 816/A lists for more than \$5,000. Several 16-bit systems can be had for little more than half that. However, none offers the versatility of the 816 series.

Worst, though, is CompuPro's attitude toward end users. From its earliest days, this company has been accustomed to dealing with knowledgeable circuit cobblers, and they like it that way. This shows first in the system software. I/O parameters on the 816 systems are software controlled, but there is no easy way to change them. If you do not want to run your terminal, printer, and modem at 9,600 baud—the standard setting—you must either use *DDT* to modify your BIOS or rewrite and reassemble the I/O routines. For an experienced programmer, these chores are not difficult; no one else should attempt them. It would be easy to provide a utility that would handle these operations from a menu, but CompuPro has not bothered.

Further, CompuPro does have a help department, but they don't want to know you. Call for aid, and their first question is whether or not you are a CompuPro dealer. If not, you are told to ask your dealer for help; if need be, the dealer, not you, can call for advice. You cannot blame the company for

wanting to avoid the expense of direct customer support, nor for encouraging would-be buyers to deal with authorized dealers who can provide some hand-holding. But this is not the way to win general-market customers.

In all, however, the benefits of CompuPro equipment clearly outweigh the disadvantages. The most advanced of their models are the current state of the art. The others were the state of the art two or three years ago—just the thing to guarantee serious business users the performance and reliability they need. If you want the best, and can afford it, look no further. Just make sure that you or your dealer can cope with the technical questions when they arise.

CompuPro, CompuPro/A \$5,495-\$6,095; CompuPro/B \$6,995-\$7,795; CompuPro/C \$8,995-\$9,995; 816-86/87 \$13,995

DEC 350 PROFESSIONAL COMPUTER

Just what is a Pro 350? Most PC users can't tell you. Unlike IBM's computers, which have different packaging, different software, and different price ranges, DEC's microcomputers are physically indistinguishable at six feet.

DEC's mass-market Rainbow and its midrange Decmate II have received a lot of limelight recently, but the Pro 350 has been selling in similar volume. Conceived as a complete business solution, the Pro 350 is a well-engineered, cost-effective, upgradable office-automation system.

The Pro 350 uses the same monitors as the Rainbow, the Decmate II, and the VT200 series of video terminals. The standard monitor is the wedge-shaped, ergonomically designed VTR201. It comes in black and white, green, or amber phosphor models. It is RS-70 compatible and displays 24 lines of 80 or 132 characters. It supports either smooth or jump scrolling, executes a full screen update in less than a tenth of a second, and has an adjustable leg allowing a tilt range from +5 to -25 degrees. Its 12-inch diagonal screen has a thin, glare-reducing coating and a built-in handle for carrying the monitor.

For users with higher budgets, the VR241 monitor produces equally high resolution in color. Running off a \$695 Graphics Option card, the VTR241 emulates DEC's VT125 color graphics terminal. The \$950 monitor has two sets of BNC connectors on the back for REB input and output. The monitor's 0.31 mm dot pitch and 62-percent antiglare filter are impressive, but at 37 pounds it lacks the ergonomic angle adjustments of the black and white unit.

From the outside, the label is all that distinguishes the Pro 350 system from the Rainbow. Like all DEC PC system units, it can be assembled and disassembled without any tools. The system unit houses the diskette drive, the Winchester, the main processor board, any option boards, and the power supply. It fits into the same floor stand as a Rainbow for convenient, out-of-the-way use.

The Pro 350 uses the same Rx50 diskette drive and the same JMB Winchester drives as the Rainbow and the Decmate II. The JMB Drive is standard and a 10MB Winchester is optional. The single-sided, quad-density Rx50 diskettes hold 400KB of data each (roughly 200 pages of text), and the basic Pro 350 system contains one Rx50 drive with two diskette receptacles for 800KB of storage. An extra dual-diskette Rx50 drive costs \$995.

The heart of the system is an F-11 microprocessor and 512K bytes of RAM that is expandable to 1 MB. To appreciate the F11 microprocessor one must take into consideration its multitasking capabilities. For example, all one has to do is select a lengthy document and execute a "print file" command. While the document is printed, it is possible to exit the print mode and return to the main menu to begin another application without interrupting the document printout. You will find this feature especially useful when transmitting files to a host computer or remote data base. You can review a document that you have just received while transmitting a data file in the background.

The Pro 350's lightweight low-profile keyboard features a full 512K typewriter array, a host of function keys, an editing pad, cursor keys, and a numeric keypad; 105 keys in all. Contrary to what you might expect, the keyboard's layout is simple and easy to use. The nonslip, matte-finish keycaps provide a positive "touch" and help reduce glare from overhead lighting. Touch typists, however, will have to get used to the left-hand region of the keyboard, in particular, the composite character and control keys.

Unlike many microcomputers that use the return key to execute a command string, the Pro 350 has a Do key that serves this function. To the left of the Do key is a Help key, which can be used to call on-line Help documentation to the screen for reference at any time.

Shortly after it released the Pro 350 with P/OS (Professional Operating System) version 1.0, Digital introduced an updated version of the operating system P/OS version 1.5. Without a doubt, version 1.5 was an improvement over the previous operating system. However, it too was in need of fine tuning. Finally, in October 1983, Digital released

version 1.7 of P/OS. Compared to the earlier releases, P/OS version 1.7 flies.

While P/OS version 1.7 is essentially the same as the previous versions, it does offer faster execution times and an enhanced prose editor. Unlike the previous editor, the new one allows you to set tabs and use function keys to store and recall frequently used editing routines. It also moves the cursor through a multiple page document with fewer key-strokes.

A floating point adapter standard on the new Pro 350 is, offering high-precision, high speed-number crunching for scientific and engineering applications.

With a sticker price comparable to that of a two-door, front-wheel-drive Ford, the Pro 350 is certainly not for first-time buyers looking to play video games or balance their checkbooks. On the other hand, the Pro 350 is a worthwhile investment for professionals who don't mind spending more for a computer backed by Digital Equipment's long-standing reputation for product excellence and a nationwide service network. And you need not worry unduly about Digital, the world's second-largest computer company, going under.

Digital Equipment Corporation, \$8,595

DECISION 1

The Morrow Designs Decision 1 is not a personal computer in the usual sense. Instead, it's a business- or industrial-grade machine designed for serious users who need long-term reliability and performance in rigorous working environments. This is a 64K Z-80 based microcomputer clocked at 4MHz, and it runs the CP/M 2.2 operating system, often called CP/M-80. It's designed to connect to a terminal with a screen and keyboard, and to a suitable printer. The internal structure is an expandable IEEE-696/2-100 bus, which has been a standard for workhorse computers for several years.

The basic system contains a CPU card or central processing unit, a 64K high-speed static RAM board that Morrow calls 65K, a Morrow Mult-I/O board, and a Morrow Disk Jockey MDA Floppy controller. The Mult-I/O board provides three serial (RS-232C) interface ports, a single 50-pin parallel interface port, a programmable interrupt controller, and a real-time clock.

In addition, the disk drive configuration may be selected when a unit is ordered. The test unit was equipped with dual double-density double-sided 8-inch floppy drives (Shugart 850s) each having a capacity of 1.2 Mbytes (1.2 million bytes). Other

possible configurations include a single 8-inch floppy, a floppy with an internal hard disk, and similar combinations with 5 $\frac{1}{4}$ -inch minifloppies.

The S-100 bus is powered by a 150-watt switching power supply, and the disk drives are powered by a separate linear supply factory matched to the drives selected. Surge suppression and noise filtration are built into the supply and need not be provided externally. However, there may be some advantage of using an external battery-operated standby or uninterruptible power supply, particularly in critical applications where continued operation through blackouts and brownouts is required. In such a case, it's important to specify external reserve or uninterruptible power supplies with sine-wave outputs. The switching power supply built into the Decision 1 will not tolerate rectangular waveforms typical of many such units.

The Decision 1 is built to last. As applications change, the system can be reconfigured to meet them, and the S-100 bus makes it easy to add powerful capabilities at any time. The S-100 motherboard has 12 card slots, of which four are used for the standard boards. That leaves eight slots for interfacing an external hard disk, adding a plug-in direct-connect modem, installing sophisticated color graphics boards, and so on. The system is capable of handling multiuser and multitasking applications, and it has extended addressing to 2 Mbytes of memory for such uses.

Internal design is clean and free of clutter. Even the interface ports are cabled to conventional connectors such as D25 male connectors for serial ports that mount on the rear panel. Those connectors are readily accessible and allow rapid connection and disconnection of cables without opening the computer. In fact, the only times the computer need be opened are during maintenance and for the installation or removal of complete boards.

The 8-inch disk drives are particularly useful, and they are well supported with software provided by Morrow Designs. The dual drives of the test unit put 2.2 Mbytes of storage on line at all times—more than enough for most single-user applications. The customized disk-formatting program provided allows these disks to be set up for six possible combinations of sides and recording densities. Essentially, diskettes may be formatted single- or double-sided (assuming double-sided drive) and with 256, 512, or 1024 bytes per sector. The single-sided 256-bytes-per-sector format allows the Decision 1 to read, write, and generally work with the format normally used for distribution of CP/M software. The double-sided 1,024-bytes-per-sector format offers the greatest amount of storage per

diskette and is, in fact, the only format on which the specialized CP/M system tracks can be installed—something not covered in the manual.

In addition, the Decision 1 can copy files from one format to another, so single-sided distribution diskettes can be copied onto more efficient double-sided ones, preferably with 1024 bytes per sector. Furthermore, the drives automatically adjust to the format of the diskette installed whenever the system is warm booted (CTRL-C). One moment, a drive may be reading single sided, the next it may be reading double-sided.

The 5¼-inch minifloppies are far more limited, however, and may restrict the user. Generally, they use hard-sectored NorthStar-compatible diskettes and have only limited formatting provisions. This is not one of the commonly used formats.

The Mult-I/O board supports three serial ports and one parallel port. On the test system, the parallel port was set up for an Epson MX-80 printer, one serial port drove an external CRT at 9600 baud, another serial port drove a letter-quality printer at 1200 baud with handshaking, and the third serial port was used for external modems ranging from 300 to 1200 baud and for computer-to-computer hardwired communications at speeds up to 19,200 baud.

It's advisable to have a dealer preconfigure the ports to the printers, modems, and CRTs being used. The serial ports all employ 8250 ACE (Asynchronous Communications Equipment) devices and are difficult to program and use for anyone not well versed in assembly language and fully familiar with the structure and programming of a CP/M BIOS. The manipulation of the three ports is tricky and is best set up at the time of purchase as a condition of accepting delivery. Because of the interfacing requirements, only technically experienced and knowledgeable users should risk acquiring a Decision 1 by mail order or other indirect means.

Given a properly written CP/M BIOS, the interface ports work well. For the test system, two BIOS programs were written by the dealer, with one directing printout to a serial port and the other directing them to the parallel port. Changing printers then required only cold booting (resetting) the system with a diskette having the proper BIOS. Morrow does provide software to reset the baud rates up to 19,200 baud on any serial ports, allowing different printer or modem requirements to be met on a moment's notice without interrupting work in progress. Typically the printer and CRT ports are preset by the BIOS, and the modem port is software-adjustable to accommodate any external

modem or direct machine-to-machine intercommunication needed.

Reliability has been outstanding. The system used by this reviewer has been in operation for 18 months, running an average of 14 hours per day, seven days a week. It's had just one service call in that time, and the failure wasn't even the computer's fault. A defective diskette from a software manufacturer had slipped through preliminary visual inspection, and an abrasive inclusion on the diskette surface scratched one of the magnetic heads in the drive. That in turn damaged other diskettes by stripping oxide from them and doing further damage to the magnetic head. The dealer had to remove the drive and have the head micropolished, reinstalling the repaired head and drive when done. Aside from that one problem, the Decision 1 has purred along.

That's not to say the product doesn't have faults. It does! The worst is poor documentation. The manual is written for a service technician or someone thoroughly familiar with the internal workings of computers. It's packed with technical descriptions and schematic diagrams, but lacks any information for a first-time user. Aside from telling how to switch on power, there's nothing on basic system operation. No details about how to choose diskette format. No explanation of why choosing the wrong format prevents copying the C/PM system onto the new diskette. Some of that information is neatly tucked into documentation files on the master-system diskette—unlikely to be discovered by new users whose first objective is to copy that diskette so the master doesn't get damaged.

The use of an "oversize" CP/M operating system also caused some problems when recompiling some user-written BASIC programs transferred into this machine from another computer. The Decision 1 used an extra 3900 memory bytes for its CP/M system compared to the other computer, costing about 6 percent of the 64K total. It was just enough to prevent compilation of older programs, each of which was written to make maximum use of the memory on the original machine and then caused memory shortage errors on the Decision 1. A considerable amount of reprogramming had to be done before that software became usable. Commercial programs generally were unaffected, however.

The double-sided 1,024-byte-per-sector disk format also can create unexpected problems. Most commercial software has no difficulty using that format, but certain programs such as disk diagnostics and disk-recovery programs may malfunction. Supersoft's *Disk Doctor*, for example, is designed

to recover data from disk crashes and accidental erasures. It won't even install properly for these drives and has been unusable. Advanced Micro Technique's *DPatch* is another program for disk alteration, file editing, file recovery, and surface analysis. With it, all functions work except the surface analysis, which indicates nothing but false disk read/write errors.

There isn't much CP/M software that won't work with the Decision 1 double-sided drives, but users must be aware that the possibility exists.

For diagnostic purposes, the Decision 1 does have its own "monitor" program that can be used to test various functions. The test system was set up to boot directly to the monitor, allowing tests to be run as needed. Keyboard entries allow testing memory locations across specified address ranges, filling parts of memory with known value, comparing and verifying memory areas using known values, and moving memory contents from one memory area to another.

Basic CPU, disk controller, and direct memory access (DMA) channel tests are done automatically on applying power. There also are a variety of switch selected tests for the CPU, registers, RAM operations, floating-point processor, and S-100 bus that may be used by service personnel or qualified users thoroughly familiar with microcomputer troubleshooting and having an oscilloscope.

In addition to the standard CP/M operating system, the Decision 1 can use Morrow Design's Micronix operating system, a derivative of Bell Laboratories' UNIX. There also have been plans for a 6 MHz Z-80 processor or a 16-bit processor as optional plug-ins.

Morrow Designs, \$4,995 for rack-mount configuration, dual 8-inch drives

DIMENSION 68000

Every week or so, another powerful new computer is announced. These days, they all seem to have 16-bit processors, MS-DOS, 128K of RAM, a floppy disk drive or two, maybe even a hard disk, and so on.

And little to no software. That is their downfall. A computer may have a 10-MHz processor and bank-selected memory, but without programs to run it's an expensive paperweight.

It is not easy for a computer company to overcome this handicap. For example, when the Atari came out, there were only a few games available for it. Only in late 1983, five years after it was introduced, did the Atari offer as many games as the

Apple; in business software, the Apple is still far ahead.

Now, dream for a minute. Imagine that someone made a machine to run all the software that's available. Not just CP/M-80 software, or IBM software, but both, and Apple and TRS-80 software as well. Right there you have the four biggest software bases in existence, with perhaps 20,000 programs among them, more than anyone could use in a lifetime. Every great program is covered there—*WordStar*, *dBASE II*, *Lotus 1-2-3*, *AppleWriter*, *SuperCalc*—in fact, every important program you have ever heard of.

What you would have is access to the software you need, without having to worry about compatibility. If it turned out that some Apple programs best suited some of your needs, while TRS-80 and MS-DOS programs had advantages for others, you could run them all without having to buy four machines. If you are a programmer, you could develop software for them all. And you could do it with just one computer—the Dimension 68000.

The Dimension is one of the post-8088 generation of micros. It is built around the Motorola 68000 processor, probably the most powerful CPU chip now in large-scale production. Running at a clock speed of 8 MHz—fast enough to make it nearly two-thirds as powerful as a very respectable mini-computer—it works here under the CP/M-68K operating system.

Two Shugart disk drives come with the standard configuration, a half-height, double-sided, double-density model giving 470K of storage per drive. Up to eight drives may be used, including both 8-inch drives and microfloppies in a variety of formats. The hard-disk controller was not available for testing but is scheduled for release during the first half of 1985.

Memory begins at 256K; it may be expanded to 512K on the mother board, and another 512K may be put in each of the six expansion slots. If even that is not enough, before the year is over Micro Craft plans to introduce an expansion box that will allow RAM expansion to 16MB—all that the 68000 processor can handle. For comparison, even main-frame computers usually run with 4MB or less.

Also included are two I/O ports, one RS-232 serial port, and a parallel port. More can be added at will. One nice feature is a utility program that lets you set the baud rate, parity, and number of stop bits used by the serial port. Speeds of up to 38.6K bits per second are possible—twice what most computers and peripherals can handle.

The detached keyboard is much like that of the IBM PC, with ten function keys at the left and com-

bined numeric and cursor-control keys at the right. The RETURN key is larger than the IBM's, and the Backslash has been moved out of the normal typing area to the left of the left shift key; this makes it easier for most touch typists to get used to the layout. The feel is springy, without the distinct tactile feedback that many people find to be the IBM keyboard's primary redeeming feature.

The 12-inch screen is crisp and clear enough to watch for hours. Driven by 64K of dedicated graphics memory, it is capable of displaying a variety of text and graphics formats. In text mode, column widths can range from 20 to 100 characters, with 20 to 50 lines per screen. Graphics resolution varies from 160 X 500 pixels in 16 colors to 640 X 500 monochrome. The character set can be redefined at will, and many character sets can be intermixed on the same screen, or even on the same line.

But what really sets the Dimension apart is its expansion bus—and the uses to which Micro Craft puts it. The Dimension's six empty slots, each with 86 connectors, give access to virtually all the machine's electronics. This design is uncommonly versatile, but to date it means that only the manufacturer's own add-in boards can be used. This is not a handicap, however, because it is Micro Craft's boards that make this such a desirable machine. Each carries a different microprocessor and comes with software designed to emulate one of the popular computers. Four boards have been released so far—one carrying an 8088, one with an 8080 processor, one with a Z80, and with a 6512. It is these boards that let the Dimension simulate other computers.

Naturally, you need an emulator card for the specific machine you want to work with. For the Kaypro, Osborne, TRS-80 Model III, or any other CP/M-80 machine, you need the Z-80 card. For the IBM, you need the 8086 card. For the Apple, you need the 6512 card. Micro Craft chose their cards carefully. By using the 8086 to run IBM software, they gained the benefit of its high-speed data bus; the 6512 also offers expanded capabilities over the Apple's normal 6502.

Each emulator card costs \$495—a marked saving over buying a new computer for each variety of software that interests you. The Dimension 68000 itself costs \$4,245; adding an emulator board for the IBM, Apple, and Z-80 machines brings the total to slightly less than \$5,800. By contrast, to run Apple software, you would normally need an Apple IIe setup, for around \$2,000; a CP/M machine—for instance, a Kaypro—would be \$1,500, and an IBM is \$3,500 and up—a total of roughly \$7,000.

The emulators proved easy to use. First, power

up the Dimension under CP/M-68K, then select the emulator program from the disk. Run it, and in a few seconds you are using what amounts to a different machine.

When you begin to use a given emulator, the display switches to the type used by that machine, and the disk drives and such also change. For instance, if you boot into the Apple emulator, you soon see the familiar "@" prompt onscreen in a 40-column display. Type "PR#3," as you would to access the wider display of an Apple with an 80-column card, and the Dimension will give you an 80-column Apple display. "PR#6" will boot from drive #1, just as an Apple would.

The Dimension even gives you a menu of ways in which to configure the "phantom Apple" being run. You can select whether or not an 80-column card is installed, printer card, and so forth, to match exactly the Apple hardware of your needs. For instance, your program might not work with an 80-column board installed; you need only de-select it via the Apple Emulator menu.

Copy-protection schemes for Apple disks often use "half stepping," or writing data between tracks. Micro Craft has added special controls to the stepper motors of the Dimension's 40-track drives to accommodate this. Thus, it can read in most copy protected software.

While Micro Craft could not outright copy the Apple ROMs, they could write software to emulate them pretty well. The consensus from the dealers was that only extremely well protected Apple software did not work; an amazing amount, perhaps 90 percent, did work.

Under CP/M-80, the display is a standard 80-column by 25 line screen; the 25th line is used to tell the disk status and which emulator mode you're running under. Everything tested under CP/M worked. Just as interestingly, there is a menu in the disk software that lets you select what format disks to read—Kaypro, Osborne, and so on. So you can load in your existing CP/M disks and read them or write to them directly. The Dimension also has a menu that allows you to specify the parameters of your disk, and the machine will configure its own drives to work with them.

In the IBM emulator, you'll find the familiar MS-DOS prompts. There was no problem reading in a number of IBM disks, and the only programs that failed were those that depended on IBM-specific hardware—programs that, for instance, expected to find the floppy controller chip at a certain I/O address. However, the Dimension's remarkable display emulated both the color and monochrome IBM boards, quite a feat of engineering. Such pop-

ular programs as *Wordstar* and *Lotus 1-2-3* ran without problems. Only Microsoft's *Flight Simulator* could not be run correctly because of problems with the display—even it would boot up to the initial screen—and Micro Craft has since modified the Dimension to run that. It is about as close as you can get to running an IBM machine.

In addition to the emulator programs, Micro Craft offers a variety of software. With the machine comes *UNIBASIC*, an interpreter about as powerful as the Microsoft and IBM BASICs, but with really superior color graphics. *UNIBASIC* is compatible with *Applesoft* but adds a number of statements and functions that programmers writing for the Dimension itself will find useful. A C compiler, a linker, and a 68000 assembler also come with the machine.

Two operating systems are also supported: SofTech Microsystems's UCSD p-System and a popular version of UNIX called IDRIS. The first machines were shipped before IDRIS became available, but it was scheduled to appear by June 1984.

In all, this is an amazingly powerful machine—far above the specsman'ship that accompanies too many new models. If a program has been written for a microcomputer, chances are the Dimension can run it. Nothing else on the market can make that claim.

For a small business faced with the task of upgrading its computer system, this machine should come as a deliverance. With the Dimension, there is no need to retrain computer operators to use new software before they can work with the new system. They can use the same old software the same old way. This offers a significant cost savings.

To be sure, good hardware and system software are not all it takes to make a machine worth buying. Micro Craft may not be able to convince the public to pay for access to such a vast library of applications; after all, Apple, IBM, and CP/M all should have at least a few programs for almost any purpose. Or they may find it impossible to win a market share when competing against the mystique of IBM. Some great machines have failed in the initial marketing phase. If the Dimension is one of them, early buyers could find themselves stuck with a computer no one can support or service.

However, the response to the initial ad campaign gives reason for hope. Both *Personal Computing* and *Byte* magazine report that the Dimension ads brought in more reader inquiries than any ad in their history. It will be interesting to see whether Micro Craft can capitalize on that early interest. If the marketing goes well, the Dimension 68000 could be one of the bigger surprises of 1984.

Micro Craft, \$4,245; Emulator cards \$495; 128K RAM expansion \$250; 512K RAM expansion board \$1,295

EAGLE TURBO XL

Eagle's latest computer gives users the best of both worlds: virtually full IBM PC compatibility as well as high speed. Taking a cue from an automotive fad, Eagle has placed a "turbo switch" on the front panel. It enables users to upshift the machine to an 8 MHz clock rate for high-speed processing or downshift to 4.77 MHz for running programs that require the more leisurely pace.

Fundamentally, the Turbo is a true 16-bit computer using the Intel 8086 microprocessor chip. The 8086 "fetches in" 16 bits of data at a time, processes them, and then outputs them. This is inherently faster than the way the 8088 chip in the IBM PC and its look-alikes handle data. The 8088 fetches two 8-bit bytes of data one at a time, processes the 16 bits, and finally outputs them in two 8-bit bytes, also one at a time.

Shifting the Turbo switch from fast to slow thus not only reduces the computer's clock rate; it also changes the way in which data is processed. The difference is astounding. When run in the high-speed mode the *Microsoft Decathlon* program appears on screen like a Mack Sennett chase scene. When slowed down it operates the way it does on the IBM PC, somewhat slower but just as tricky. In a similar vein, in the Turbo mode the bullets in the World War I section of the *Microsoft Flight Simulator* seem to really fly.

Although running the *Microsoft* games is a good indicator of its IBM PC compatibility, the Turbo was meant to be a rapid business machine that is able to run practically all the PC's software, including IBM's own demonstration disk and *Lotus 1-2-3*. Eagle provided emulation of 8088 in order to permit Turbo users to run interactive software with routines timed to fit in with the 8088's processing rate. Otherwise, screen messages and timed data entry screens would fly by faster than the user could read or react to them.

The Eagle Turbo XL comes equipped with one half-height 320/360K floppy disk drive and a 10 MB Winchester hard-disk drive. A version with a 32 MB Winchester has been exhibited, but at press time it hadn't been officially announced nor given a price tag. As on Eagle's PC and Spirit series, hard disks on the Turbo are interfaced through an Adaptec controller board rather than a SASI controller used in the 1600 series. Interestingly enough, Eagle provides a dip switch on the Turbo mother board for those who wish to implement an option to use the

Eagle 1600's double-sided quad density (96 tracks/inch) 780 KB capacity disk format. In addition to clock battery back-up, the floppy disk controller board has two drive connectors and is thus able to support a second drive. This raises the question of whether Eagle intends to market a Turbo with two floppies only, analogous to the 1620. At the moment Eagle answers no, despite every indication to the contrary in the Turbo user's guide.

Standard on the Turbo are a parallel and a serial port, unlike other Eagle models which have two serial ports. Another departure from Eagle's other 16-bit machines is that the ports are no longer installed directly on the mother board; instead they occupy an expansion slot. In all, there are eight expansion slots, three of which are occupied by the two disk controller boards and the port interface board. A video adapter board is optional but necessary. Eagle makes both a monochrome board and a color/graphics board.

The Turbo's expansion slots are readily accessible by removing the cover of the cabinet, which is held by six Phillips head screws. Memory expansion is not so easy to accomplish, because it requires removing the entire disk-drive assembly to get at the memory chip sockets on the mother board.

The good news about the 256 KBytes of installed memory—expandable to 512 KBytes only, no intermediate amounts—is that the Turbo uses high-speed 150 nanosecond 8 KByte RAM chips rather than the slower 200ns chips. Use of such chips is in part responsible for Eagle's rapid processing rate, and since they are not in so high demand, the price is lower.

Eagle bundles with the Turbo only the MS-DOS 2.11 operating system and the BASICA (GWBASIC) programming language. Other operating systems that are known to support the Turbo are CP/M-86, Concurrent CP/M-86, Oasis-16, Venix, and SMC Thoroughbred. Local area networking is available with EagleNet, Eagle's version of ArcNet.

Except when running at high speed, the actual operation of the Turbo is not noticeably different from the IBM PC and most of its 8088 look-alikes. It was not compared for speed against 8086-based machines other than Eagle's own 1600; the Turbo is decidedly faster. The 83-station keyboard, now standard on Eagle 16-bit computers, is actually a "key tronic" KB 5150 board. Dissatisfied IBM PC users often choose it to replace their IBM boards. The keys are where typists expect them to be.

To sum up, the Eagle Turbo XL is both a personal computer and a rapid data-processing machine. It is a design that stands on its own, not a compro-

mise. The Turbo is likely to spawn many imitators. Good job, Eagle.

Eagle Computer, Eagle Turbo XL \$4,995; Monochrome Adapter \$295; Color Adapter Board \$295; Monochrome Monitor \$329; Color Monitor \$680

EAGLE 1600 SERIES

Although the Eagle 1600 Series shares much in common with the IBM PC and clones, Eagle marched to its own drummer when it designed this line of fast 16-bit computers. And even die-hard IBM fans will have to agree that many of the differences built into the Eagle 1600 Series are improvements.

The computers in the 1600 Series differ primarily in storage capacity. The Eagle 1620 has two 780K floppy disk drives, while the 1630 and 1640 each have one such drive plus a Winchester hard disk—10 megabytes in the former and 32 in the latter. The 1640 also comes with a full complement of 512K of RAM rather than the 128K of the other models. The high-density floppy format is the same as that used in Eagle's IIE series 8-bit models. A utility program supplied with the 1600 reads Eagle 8-bit data disks and converts them to 16-bit files. This upward compatibility can be useful. It makes possible the use of the less-expensive 8-bit machines for entering data to be shared with the pricier 16-bit models.

IBM-disk compatibility has not been overlooked, either. An Eagle 1600 can read or write to PC-DOS or MS-DOS 320K double-sided diskettes, automatically sensing the format, thus allowing the use of PC-type software. When this was written, there was no MS-DOS 2.XX operating system—which supports the 360K double-sided format—available for the 1600, although a version of 2.11 has been circulated to beta test sites. At present, new software must be provided in DOS 1.25 format and copied to a 780K floppy or the Winchester disk in machines so equipped. The problem is not as great as one might fear; much of the MS-DOS software is made available in 1.25 format because it is readable with both the earlier- and later-released operating systems. The bottom line is that once the software is copied by the Eagle 1600 onto one of its hard or floppy disks, format is no longer a consideration—unless you want an IBM PC or clone to read a disk produced on the 1600. The problem is that 320K disks produced on the Eagle 1600 may be unreadable to other machines. That's because the Eagle writes the PC format with a 96 track-per-inch read/write head, while the IBM PC and clones use a 48 track-per-inch head.

The relationship of the 1600 series to the IIE se-

ries is also reflected in the bundled software. Along with the MS-DOS and CP/M-86 operating systems, the Eagle 1600 comes with the *Eaglewriter* word processing and *EagleCalc* spreadsheet programs. These are MS-DOS versions of the CP/M *Spellbinder* and *Ultracalc* programs bundled with Eagle's 8-bit machines.

The keyboard reflects a largely successful attempt to provide keys for addressing the commands of the word-processing program keys that also serve as function keys for MS-DOS software. Above the standard numerical keys is an uppermost row marked F1 through F19. The first 14 of these keys are also marked with word-processing commands used with *Eaglewriter*. Five additional keys, marked F20 through F24, are located at the bottom right of the keyboard. F15 through F24 are not marked for word processing, though some of them do provide such commands. Three additional keys, fully dedicated to word processing and marked as such, are located above and to the left of F20 through F24.

In practice, the use of word-processing function keys is less confusing than describing their arrangement on the board. Nonetheless, the inconsistency of their arrangement and omission of some of the markings on the keys is inelegant. Most other aspects of the 1600 keyboard, however, compare quite favorably with those of the IBM PC. That action is soft but positive, with a layout that is not difficult to master. Location of the left-hand key where touch-typists expect it is an obvious but important departure. Welcome is the positioning of so many of the function keys above the numerical row. Also appreciated are dedicated cursor keys. They do not serve optional—and sometimes conflicting—duty as calculator pad keys, as in the IBM PC. These are located in an area adjacent to the generously sized return key and the calculator pad. Using the shift key with the appropriate Arrow keys activates the END, PAGE UP, and PAGE DOWN functions. There is a dedicated HOME key. The Backspace key doubles as the left cursor key, though for some software you must use ALT-BACKSPACE to move the cursor to the left without erasing characters.

Because of the dedicated-cursor arrangement, the Eagle 1600 has not a NUM LOCK key, nor does it need one. If necessary or desirable, however, the sequence CONTROL-ALTERNATE-N can substitute for NUM LOCK, switching on to activate or off to deactivate the Eagle's pad keys to perform all of the cursor and scrolling options available on the PC's pad.

The Eagle 1600 keyboard has two very helpful

locking keys. One is the usual alphabet lock, which locks only the alphabetic characters to uppercase. The other, marked SHIFT LOCK, locks all of the character keys—alphabet and nonalphabet characters—into the uppercase mode. The latter is not found on most keyboards and is quite handy for typing a continuous string of uppercase symbols, such as a long underline.

A monochrome video display is included in the price. It supports the 80-character by 25-line format that is standard with MS- and PC-DOS computers. The 9 x 14 dot-matrix video characters, along with 720x352 pixel graphics are eminently sharp. The ROMed character set is the same as that on the IBM PC. The antiglare screen uses the P39 green phosphor, which has a slight persistence that causes a smooth delay when the brightness control is adjusted. Also annoying, a slight ripple appears in the screen image during scrolling.

The 1620 and 1630 come with 128K of RAM. That can be increased to the full capacity of 512K (standard with the 1640) by installing 384K of 20-nano-second 8K chips on the mother board. When total memory goes beyond 256K, however, an 8203 memory-refresh chip is necessary.

Unlike the IBM PC, the Eagle 1600 requires eight instead of nine chips per bank of 64K memory. IBM's ninth chip is required for parity checking, a built-in error-checking routine often used in main-frame computers. This practice is a largely unnecessary holdover, dating from before the time when microchip memory was reliable, and it reduces the PC's processing speed by an estimated 15 percent. Even without the ninth chip, the integrity of a 1600's memory switching on the computer will invoke a memory-test program resident in the machine's firmware.

Installing memory chips on the 1600 is not quite the simple task it should be. In addition to removing the cover of the system cabinet, you must detach all disk-drive connections and remove the entire disk-drive assembly. Fortunately, the operation does not need to be performed every day. And, thankfully, adding expansion boards is a simple affair. Once the cover is taken off, the expansion assembly is readily accessible.

In all, there are eight expansion slots in the Eagle 1600 computers. One is occupied by the parallel-printer board, which uses a standard Centronics 36-pin female connector. Another is occupied by the serial board, which has two RS-232 ports accessible through DB25 female connectors. The floppy-disk controller board resides in a third slot, and the monochrome graphics board in a fourth. That leaves four open slots in the Eagle 1620. In the

hard-disk models, the Eagle 1630 and 1640, a fifth slot is taken by the SASI hard-disk controller board.

All that room available for expansion could be an embarrassment of riches, considering that most of the functions requiring additional boards in many computers are already provided in the Eagle 1600. The manufacturer offers some powerful options for those open slots, including a board with eight-port serial for addition of local or remote terminals. Eaglenet, a local area network for adding up to 64 terminals is another option. Hard-disk backup on a standard VHS videotape recorder is also available from Eagle. And of course, there are many special-function boards available from numerous manufacturers.

In most respects, IBM compatibility should not be an issue. The Eagle 1600 was designed as a true 16-bit computer using the Intel 8086 microprocessor operating at 8 MHz. Compare this to the IBM PC and its clones, which use the Intel 8088 chip running at 4.77 MHz. While both chips process 16-bit data internally, the 8088 uses an 8- rather than a 16-bit data bus and must "fetch" two 8-bit bytes, one at a time, to process the 16 bits. The bottom line is that the Eagle 1600 and other 8086-based computers can process data faster than the IBM PC and other 8088-based machines.

Most users do not work with applications that demand speed in data processing. The efficiency of word processing and spreadsheet programs—the most common small-computer applications—is more dependent on the speed of the operator and the printer than on the speed of the computer. Activities such as searching and sorting databases or performing complex numerical calculations demand considerable processing time. For certain applications hard disks can speed up processing on slower machines. That's because tasks such as sorting depend in part on the speed of reading and writing to the data-storage device, and hard disks can be written to and read much faster than floppy disks.

Speedier processing can be achieved when a hard disk is used with an inherently rapid computer. An IBM PC with a 10 megabyte hard disk took 16 minutes and 30 seconds to alphabetize a random *dBase II* file of 1,000 names and addresses. An Eagle 1630 took 6 minutes and 50 seconds to perform the same task. A single-key search on a file of 3,000 names and addresses in *Qbase* took 2 seconds on an Eagle 1630 as compared with 10 seconds on an IBM PC. Another benchmark not dependent on disk reading and writing was an Eratosthenes sieve program, written in Lattice C, for finding prime numbers. The Eagle 1630 performed

10 iterations of the program in 5.8 seconds; an IBM PC took 20 seconds.

The results of such tests are convincing evidence of the Eagle 1600's speed. And it is speed and convenience rather than strict IBM PC compatibility that characterize the Eagle 1600 Series. With the exception of *Lotus 1,2,3*, the *Microsoft Flight Simulator*, or other programs that make call on the PC's hardware rather than on the operating system, Eagle 1600's run MS-DOS—as well as CP/M-86—software. Communications software may be another exception, since the 1600's port addresses are not the same as the IBM. However, several powerful communications packages, including *ASCOM*, are available for the 1600.

An oddity in the Eagle's pricing structure makes it more economical to buy a two-floppy 1620 and to connect an Eagle File 10 (10 megabyte) or File 40 (32 megabyte) outboard hard disk through a SASI board you purchase separately. In this way, a system with a 10 megabyte hard disk and two floppy disk drives can be had for only \$120 more than the 1630 with just a single floppy. A system with two floppies and a 32 megabyte File 40 actually costs \$380 less than the 1640 with just a single floppy, if one overlooks the price of 384K of additional memory needed to match the 1640.

In the final analysis, a computer should be chosen on the basis of its fitness for the intended application. The Eagle 1600 is built for heavy data processing and potential expansion for networking and multiuser situations. Its characteristics as a word processor are excellent, but given the price of these computers, word processing ought not be the sole reason for choosing one.

Eagle Computer, Eagle 1620 \$4,495; 1630 \$6,995; 1640 \$8,995; File 10 \$2,495; File 40 \$3,995; SASI board \$125; 8087 Processor \$495; Color monitor board \$295; 8-port serial board \$295

FUJITSU MICRO 16

Fujitsu is one of the corporate giants that have lead the Japanese business world since the economic recovery after World War II. They have made a fine reputation as a supplier of integrated circuits and in communications. In fact, they are Japan's largest computer company, with sales of \$2.3 billion last year.

If Fujitsu is the IBM of Japan, the Micro 16 is their answer to the IBM PC. It is a powerful computer, solidly backed by a company with years of experience, and at \$3,995, it is priced reasonably. If you're thinking of getting an IBM, the Micro 16 is worth a careful look first.

The Micro 16, to begin with, has two microprocessors inside it, one more than the IBM. Its primary processor is an 8086, the more powerful brother of the 8088 IBM uses; backing it up is a Z-80, the standard processor for the CP/M-80 operating system.

This single, basic difference provides one good example of why the Fujitsu is such a good design. Both the IBM's 8088 and the Fujitsu's 8086 are 16-bit machines; this means they deal with 16 bits internally. However, the IBM's 8088 speaks to the world in "byte" format, or eight bits at a time; when it needs to store one of its internal 16-bit "words," it must send it out to memory as two eight-bit bytes, one after another. With the Fujitsu's 8086, however, memory access is done directly, a 16-bit word at a time. For the end user, this means much faster operation on anything involving memory, which means most anything in a computer.

Next, Fujitsu realized what IBM did not: that there is a vast library of software compatible with the Z-80 microprocessor, while there is very little for the 8088. IBM chose to use the single processor and left its early users with little software indeed. Fujitsu gave its users a Z-80 to operate with, which means they could begin using the CP/M-80 software library immediately.

Even today, with a concerted effort by software producers to convert their software to IBM's 8088 processor and to bring out IBM products, the CP/M-80 (Z-80) library of software is much larger. Hence, even today, you can do more with a Fujitsu than with an IBM.

With IBM, you have to buy a bare bones system and start adding to it. Fujitsu bundles its system with popular software, including a word processor and electronic spreadsheet at no added cost. What else do you get for the base price? A variety of features for which IBM charges extra: two double-sided double-density drives, holding 320K each; 128K of memory, expandable to one million bytes (IBM comes with 64K and charges to upgrade to 740K maximum); a serial and parallel port; and high-resolution color graphics. Furthermore, there are ports to plug in a light pen and mouse. This offers all sorts of interesting possibilities for the future, if the mouse retains its current popularity.

In other words, while the initial price of an IBM is less, by the time you expand it to equal the features that come standard with the Fujitsu, you'll have spent far more. There's just plain more value for your money in this Fujitsu machine.

What can you do with a Fujitsu? Lots of different things. To begin with, you can immediately run CP/M-80 software. Some well-known names developed

for CP/M-80 are *dBASE II*, *WordStar*, and *Multiplan*. All these are now available for MS-DOS as well, but most of the 2,000 or so CP/M-80 programs are not.

However, if you have MS-DOS (IBM) software, you can run that on the Fujitsu as well. Software that relies on the IBM hardware probably won't work, but this is a relatively small percentage of the MS-DOS market. This will be an even smaller problem as the market develops; owing to the popularity of IBM not-quite-compatibles, software companies have begun to avoid using hardware features they cannot be sure of finding on other machines.

You can also use CP/M-86, the less popular 8088/8086 operating system, or Concurrent CP/M-86. Concurrent is a powerful tool that lets you run four tasks at the same time, with each taking up to 256K of memory. Concurrent CP/M-86 is an up-and-coming operating system, for it allows you to do more at the same time with your machine. For instance, you can be printing a file with one task, editing another file with a word processor as another task, calculating data with a spreadsheet as the third task, and doing yet something else with a fourth task. You can switch between tasks instantly. The newest revision level, 3.0, reportedly will run MS-DOS software as well as its own. This improvement should be available by the time this review appears.

The Fujitsu also gives you a very good color RGB display, with resolution of 640 x 200 in eight colors. The Fujitsu dedicates an additional 48K of RAM to this task. You can't do this on the IBM without taking up some of the IBM's main memory and without an additional color graphics card. Furthermore, on the Fujitsu you can even specify intensities in these colors. This allows control over foreground/background blinking, shadowing, and so on.

Fujitsu dedicates a 6809 processor to this 48K of display. 6809s are powerful processors indeed; you usually see them in video games and the like. Thus the Fujitsu really has four separate computers inside; the 8086, the Z-80, an 8048 in the keyboard, and the video processor, the 6809.

This points to a new trend in computers, the use of multiple processors. Though it has not yet become popular, Fujitsu is starting to take advantage of it. It used to be that computers were so expensive and processors so costly that only one could be included in any machine. The IBM PC and the Apple are still good examples of this outmoded thinking.

Now dedicating a processor to a given task gives you extra power two ways: The independent processor works without interruption on a given task—for instance, controlling the display—so that the

main processor does not have to worry about peripheral tasks. Thus, the display, or whatever, is handled more efficiently, and the main processor is free to execute its program much more quickly. This is an exciting scheme that is available on really superior computers and that you will be seeing more of shortly. For instance, a 68000 card is available for the Apple, as is a fast 6502 "accelerator" card, both to speed things up. And the Atari has always had a dedicated video processor, called ANTIC. In the Fujitsu, this technique is used to good advantage.

The display itself shows just how much work Fujitsu's designers went through to make this machine really comfortable to use. First, it provides a sharp video image, to avoid eyestrain. Second, the background is flat black, not grey or dimly lit as in other monitors; this significantly increases contrast. Finally, the whole thing can be tilted, so you can select the exact display angle that is most comfortable for you.

The keyboard is also a pleasure to use. The hordes who have often complained about the IBM's keyboard, and in particular the nonstandard positioning of the return-shift-ALT group, will find no problems in the Fujitsu keyboard. There's a nice tactile feedback in this keyboard that also helps to make it a pleasure to type on. While the IBM keyboard quickly tires the fingers of many typists who must strain to reach certain keys in odd positions, Fujitsu's keyboard is effortless to use.

The detachable keyboard is split into four functional areas. First, there's the standard QWERTY section. Next, there's a separate keypad for entering numbers; people who use their computers for accounting and similar chores will appreciate this feature. There are ten programmable function keys across the top of the keyboard. And finally, there's a group of ten editing keys for inserting and deleting text and positioning the cursor.

There are five expansion slots, but these turn out to be one of the Micro 16's few weak points. They are based on Fujitsu's 130-pin bus, which means that neither IBM cards nor any other common variety can be plugged in. Unless this computer catches on well enough to attract third-party vendors, you'll be locked into Fujitsu's product line. While the machine is so new that not many expansion cards have been announced, one that is available is a 68000 coprocessor. The 68000 is a very powerful, fast chip that gives you easy access to the UNIX operating system.

In case you need more memory, a 10- or 20-megabyte hard disk is offered as an option. Fujitsu has made this addition compatible with the Corvus

OmniNet protocol, so the Micro 16 can be made part of a larger networked system, a useful feature for large offices and the like. One hard disk can be shared by several machines, lowering overall cost of the system while increasing the performance of all its parts.

How about software? *WordStar*, the most popular word processor now in use, and *SuperCalc 2*, the most popular spreadsheet, both come packaged with the machine. That's around a \$600 value in software alone. CP/M-86 and CP/M-80 come with the machine; MS-DOS and Concurrent CP/M-86 are both available if you need them. If you need programming languages, then BASIC, Fortran, Pascal, C, and even FORTH are available on the Fujitsu.

The documentation proved both usable and easy to read. This made it easy to set up the machine and get it running immediately. And once you get it running, *WordStar* and *SuperCalc 2* let you do useful and powerful things with it immediately.

This is a great machine, with all the right features in the right places. It has the proper balance that a business computer should have: plenty of raw computing power, good software, and enough memory to use them both efficiently. The keyboard is a joy to work with. Save for the limited opportunities for expansion now available, it is a much superior machine to the IBM PC. If you ever work with the Fujitsu, it will almost surely spoil you for other computers.

Fujitsu Microelectronics, \$3,995

HEWLETT-PACKARD SERIES 200 MODEL 16

How would you like the power of a 32-bit mini-computer in a box the size of a terminal? A small terminal at that? The Series 200 Model 16 Hewlett-Packard is that and more.

The Model 16 is the junior member of a family of personal desktop computers Hewlett-Packard has aimed at the professional engineer. Hewlett-Packard is well known for their desktop computers, and this recent addition to their lineup is a winner.

The Model 16 manages to pack the entire computer into the same cabinet as HP's 2382A Office Display Terminal. It takes up less than 238 square inches of your desktop, compared with 420 square inches for the IBM PC, or 361 for the Apple III.

The processor is the Motorola MC68000, a 16-bit microprocessor with a 32-bit internal architecture. The external clock speed of 8 MHz, combined with the powerful instruction set, gives the user a signif-

icant speed improvement over the Intel 8086, and an enormous advantage over the 8088 used in the IBM and many other personal computers.

Add to that 128K of RAM, a crisp 9-inch white-on-black screen with 24 rows of 80 characters, a full detachable keyboard that most typists will find easy to use, an RS-232 port and an IEEE-488 port, all standard, and it's not a bad package for a base price of \$3,985.

Some form of secondary storage is necessary of course. HP's offerings range from a single 3½-inch floppy holding 270K for \$900, up to 132-MB hard disks for \$19,900. Adequate intermediate choices might be a dual 3½-inch floppy for \$1,270 or the 5-MB Winchester for \$3,040. All drives connect to the CPU with the IEEE-488 bus cable, making system hookup fast and easy.

An interesting feature of the keyboard is a device called a "knob." This is a little disc that sits in the upper left corner of the keyboard. It can be twirled with a finger for input to a program. HP's editors use it to position the cursor, and it can be used to adjust values in a process-control application, or anything else a clever programmer can think of.

Other accessories available include printers, starting at \$795. Several plotters are available including the nifty little two-pen model 8½×11 HP7470A for \$1,095. A graphics tablet is available, along with extra RAM, I/O cards for interfacing to the "real world," bubble memory, and color graphics controllers.

A good array of software is available for the 9816 family. An extensive line of application software is available. This includes the ever-popular *VisiCalc* and *Context MBA*, incorporating spreadsheet modeling, graphics, word processing, database management and telecommunications. Other HP-supported programs cover such fields as graphics presentation, word processing, terminal emulation with file transfer, project management, accounting, statistics, interior design, and a wide variety of engineering software—statistic, optical filters, AC circuit analysis, structural dynamics, topographic modeling, to name but a few. There is even a version of the original *Adventure* game.

However, HP has always specialized in supporting knowledgeable users who need to develop their own custom software. Thus their real strength is their own version of BASIC, which is available in either RAM- or ROM-based versions. This BASIC is compatible with that used on other HP computers, so portability should be fairly easy for non-machine-dependent programs. It has some differences from other BASICs, such as on the Apple or IBM PC, mainly in the areas of input-output, graph-

ics, file handling, and subprogram usage. An experienced BASIC programmer should have little trouble in adjusting to them.

A set of extensions to BASIC available as an option adds enhanced editing and debugging capabilities, matrix operations, string utilities, event controls for real-time programming, support for calling Pascal or assembler routines, and many other enhancements to I/O and graphics. One interesting extension is the "Shared Resource Manager" support, which allows several HP computers to share a single large hard disk.

Also available is HP's version of *UCSD Pascal*. *Pascal 2.1* is a fairly faithful implementation, but compiles directly to 68000 machine code instead of to "p-code," giving an additional speed increase.

The Editor is a close copy of the UCSD editor, with the addition of support for the "knob" on the keyboard. Separate compilation is supported through HP extensions to standard Pascal. The Filer provides the ability to manipulate data on disk, and the Librarian allows the user to build libraries of custom procedures. Standard I/O and graphics procedures are supplied with the Pascal system. A debugger and assembler are also provided.

Both Pascal and BASIC are complete systems. All operating system functions are integrated into the language system. An alternative is CP/M-68K with a custom BIOS by HP. It is compatible with CP/M and CP/M-86, and comes with the Digital Research C compiler. The usual CP/M utilities Pip, Ed, Stat, Submit, and Dump, are supplied. HP offers direct support through phone-in consulting centers.

Another language available is a FORTRAN-77 compiler from International Electronic Machinery, Inc. It runs on the Pascal system in place of the Pascal compiler and can share compiled modules with Pascal, or vice-versa. Creative Solutions, Inc. offers *Multi-FORTH*, an enhanced FORTH system that allows multitasking, and comes with floating point support, a full-screen editor, an in-line structured assembler, and a computer-aided instruction course that teaches FORTH to the novice user.

Hardware add-ons are less well supported by third-party suppliers. However, Hewlett-Packard itself supplies a wide variety of instrumentation interfaces, AD/DA converters, and similar devices. Nearly all are aimed at scientific and technical users, the firm's traditional market.

The scientific and technical users are clearly the Series 200's intended market as well. But given the quality of the hardware, the comfortable screen and keyboard, and the wide variety of business-

oriented software, they are well worth considering for the office as well as the laboratory.

LISA

Steve Jobs, Apple president, thinks of Lisa as "the personal computer of the 1990s"—and he may be right. Lisa, which could be tagged the "Super Apple," was first introduced late in 1982, the product of a revolutionary but logical approach to the business of designing a microcomputer. Instead of striving to improve on existing machines, Apple's engineering team decided to look at the user's needs, and came up with a computer that was easily integrated into the user's workplace and work habits. As a result, Lisa brought some brand new concepts to microcomputers and influenced the design of other computers which followed.

In spite of advanced features, Lisa (for "Logic Integrated Software Architecture") did not sweep the marketplace in the beginning, for several reasons. First, she was too radical for many buyers—and you'll see just how radical as we review her components. For another, she was base priced at \$9,995 for the entire system, less printer—too rich for all but business buyers. Finally, she wasn't compatible with anything—a strange situation in a world where computer buyers have learned to shop for compatibility in both software and hardware.

But since Lisa's slow introduction, the Apple marketing team has done a great deal of rethinking. They created three Lisas instead of one, in different price ranges: a floppy-disk version, a 5M hard-disk version, and a 10 M hard-disk version. Recently, they brought out Macintosh, a new, smaller 32-bit machine that became the junior member of the Lisa family.

Lisa is built around the powerful Motorola 32/26 bit microprocessor chip, the MC68000. The first departure from standard design comes in her huge RAM internal memory. The sophisticated programs now heading for market will need lots of RAM, so most buyers today look on 256K of RAM (expandable later to 512K to allow space for advanced uses) as a good starting place. Lisa stunned buyers by offering a megabyte (1 million bytes) of RAM.

Why so much RAM? Because with that much internal memory and the integrated design of the hardware and software, *all* of Lisa's programs can run at the same time. With most microcomputers, you load and use one program at a time. To switch from word processing to a spreadsheet, you shut down the word processor, change disks, and load the spreadsheet software. Not so with Lisa. All her programs are loaded at one time, and they all work

together. That's what is meant by integrated software.

The software system includes *LisaWrite*, a word processor; *LisaCalc*, a financial spreadsheet; *LisaGraph*, a business graphics package; *LisaDraw*, a personal graphics package; *LisaList*, a filing system; and *LisaProject*, a project management system. It is difficult to think of all of these as one program, but that essentially is the story.

The amount of RAM was changed when Lisa came out in three versions. Now you have the Lisa 2, the minimum model, with 512K of RAM and a 3½-inch disk with a huge 400K storage capacity. Next, you have Lisa 2-5M, with the same combination, plus a 5M hard-disk drive in a separate cabinet. Finally, there is Lisa 2-10M, the biggest of the three, with the same 512K RAM and 400K disk storage, but with 10M of hard-disk storage built into the main box.

On the models with 512K (½ megabyte) of RAM, you can only run programs designed for the Macintosh. To run the Lisa software mentioned in the previous paragraph requires the full megabyte of RAM, so you must add another 512K of memory. There's nothing wrong with Macintosh programs and by the end of 1984, some 400 should be available, so this means plenty of applications software for Lisa. But since Mac comes with only 128K of RAM, its programs are smaller and don't take advantage of the nifty integrated software features available in Lisa. The Mac programs, however, have more bells and whistles on Lisa than they do on Mac.

Other specifications include two standard serial ports and one standard parallel port; an RS-232C with half- or full-duplex channels; a detached IBM Selectric-type keyboard; a built-in speaker; and three expansion board slots.

Graphics on Lisa are nothing short of sensational because of the high resolution black-and-white video screen: 720 dots × 364 lines. Most tube manufacturers consider 640 × 220 as high resolution, and 320 × 200 as standard. (For those who don't know video tubes, 320 × 200 means a picture made up of 320 dots across the screen and 200 lines down the screen. The higher the numbers, the smaller and more frequent the lines and dots, resulting in a sharper, better-defined picture. Hence the term, "higher resolution.")

Type on the screen is a soft gray and easy on the eyes. You can have documents with up to 132 columns (40 lines deep) on the 12-inch screen because of the high resolution, and while this results in very small type, the words and numbers are sharp and easy to read.

Lisa's operating system is developed specifically for the machine. Written in Pascal, it is big and is one reason the internal memory must be so large. It is not compatible with any other DOS on the market, so all software developed for Lisa must be written specifically for its system. You can't use software made for other machines, including Lisa's grandfather, the Apple. You can run Macintosh software on it, as we said.

There is, dealers say, much more Lisa software on the horizon by suppliers other than Apple, but most of it will be operated under UNIX. Thus, to use it, you'll have to buy the UNIX operating system for an additional \$395. UNIX, of course, offers some advantages of its own, but it won't be terribly convenient to have to deal with two operating systems.

Lisa's mouse is famous for having given rise to the use of mouses on a number of other computers. Lisa's mouse wasn't the first on the market, but hers was the first one-button mouse and in a way legitimized the use of mouses with computers. The single button makes the mouse a lot less complicated and easier to use.

For those who still think a mouse is a small, furry, cheese-seeking critter, we should explain that a modern high-tech mouse is a small box, the size of a pack of cigarettes, attached by a cable to the computer. When rolled on a flat surface beside the computer it moves the cursor very rapidly on the screen. On computers without a mouse, the cursor is moved by touching keys on the keyboard, either up and down or side-to-side, never diagonally across the screen. The mouse, however, moves the cursor at lightning speed in any direction and is a great timesaver. If you are keyboard oriented, as most of us are, you'll have to get used to mousing instead of keying. You'll also have to keep a space available beside the computer for the mouse to play in, and for those of us who aren't neat, that's not easy.

Once the cursor has been moused across the screen, pressing the button on it executes a command. For example, you move the mouse to a menu on the screen, then press the button to call up the program you want. More complicated commands can be executed by pressing the button more than once. Mouse users claim that after they become rodent-oriented, their use of the keyboard is cut down. Essentially, Lisa is controlled by mouse power, and keying is reserved for typing.

In regular use, Lisa is highly visually oriented. Instead of typing commands to ask for things, you position the cursor on tiny graphic symbols that appear across the bottom of the monitor. These symbols are pictures of what you want to do. For

example, there is a tiny picture of a trash can—to indicate that you want to throw a file away. Highlighting the drawing of a calculator shows that you want to use the computer as a conventional personal calculator.

This combination of symbols and mouse power not only controls cursor movements and command and menu choices, but also is used as an artist's brush for painting and a pencil for drawing graphics at spectacular speeds. The combination also simplifies the entire computing operation, since the user doesn't have to remember, or look up, commands. They are all visible on the screen.

In addition to the little pictures at the bottom of the screen, there is another menu at the top of the screen consisting of a string of words. This is an interesting pull-down menu, a neat idea for selecting Lisa functions.

Let's assume you have called up *LisaWrite*, the word processing program. Across the top of the screen are the words *File/Print, Edit, View, Disk*. Move the mouse to place the cursor on *File/Print*, touch the button, and move the mouse downward slightly. This pulls down a short menu like pulling down a window shade from the top of the screen. Put the cursor on the words *Open File* in that menu and touch the button. Presto! The file drawer opens. Suddenly the screen is covered with titled graphic representations of all the documents in the file. Next, use the mouse to select the specific document you want to work with and it appears on the screen. Describing this routine takes longer than doing it.

In studying the way people work, the Apple engineers noticed that the average executive works on stacks of papers by thumbing through them, referring to them, moving them into different piles. So Lisa has a "windowing" facility on the screen in which one document lies over another just as in a desktop stack. Parts of each document are visible, and the stack can be shuffled, to call any document to the top of the pile to be worked on. Each document has a window that lets you scan a huge workspace. By pointing to arrows at the corner of a document, you can scan this window left, right, up or down.

The system is so well integrated that you can take data or graphics from one document and move them to another document right on the screen. There is also a cut-and-paste facility. If you draw a picture on one document, you can outline all or part of it, lift the outlined part, and paste it in place on another document.

Combining all of these facilities, you could use data from a *LisaCalc* file to create a bar chart with

the *LisaGraph* program. You could then clip this chart and paste it into a page being written on the *LisaWrite* program.

Integrated software of this type is a glimpse into the future of microcomputing, because this is where program writing is headed. But for most micros, getting to this stage is an evolutionary process that is just beginning. So Lisa is, in fact, a prototype of the 1990 desktop computer.

Lisa, for all of her marvelous features, isn't perfect. She has some annoying problems. One is the boot-up time. She takes several minutes to go through her system checkout and get going after you turn on the switch. Users will be tempted to leave the machine on for long stretches to avoid the start-ups, and apparently the designers thought this might happen. The screen automatically goes into the "dim" mode if the computer sits unattended for more than a few minutes. This prevents burning of the tube phosphors that can occur on any CRT when a bright picture is left on too long, a condition that users of Pong and other early TV games discovered. The moment you touch the keyboard, the screen flips back to the bright mode.

The super friendly atmosphere created by Lisa's little symbols is nice in the beginning, but after a while accessing programs this way seems a bit slow and tedious and you wish there were some short cuts. The mouse moves the cursor at almost unbelievable speed, and once you have a program up and working, the speed of execution is fine. But there are slow times in between that make you want to grind your teeth.

There is a problem of some programming deficiencies. For example, *LisaList* is exactly what its name implies, a program for listing. It is not the kind of database manager required by many businesses. This means that somewhere, somehow, a database manager for the system will have to be created. For *LisaWriter*, there is a need for a spelling checker and other sophisticated additions that are rapidly becoming standard in the better word processing systems.

In summary, how good is Lisa? Very good. A fine job of innovative engineering. Should you buy it? Yes, if the stiff price doesn't bother you and the existing programming takes care of your needs. But before making the decision, you should definitely see your dealer and spend an hour or so trying each of the programs.

Lisa 2 (512K RAM) \$3,495; Lisa Desktop OS \$395; Lisa 2 (1024K RAM) to run integrated software \$5,385; Lisa 2-5M (includes 5M hard disk) \$4,495; Lisa 2-5M with 512K extra RAM + OS \$6,385; Lisa

2-10M (with built-in hard disk) \$5,495, with 512K extra RAM + OS, \$7,385; integrated software package (6 programs) \$2,400; Mac OS \$195; Dot-matrix Printer \$695, with parallel interface board, \$895; Daisy-wheel Printer \$2,195.

MAD 1

MAD, the user's guide tells us, stands for "modular advanced design." It sums up this MS-DOS computer pretty well. Any 80186 machine qualifies as "advanced," at least until 1985. And the hand of a designer is clearly visible in the MAD 1.

In fact, the impression that this is a "designer computer" sticks with you so strongly that it slightly overshadows the machine's performance. The MAD 1 is almost self-consciously trim. There are four separate boxes—one each for the system electronics and the disk drives, plus separate monitor and keyboard—all connected by a tangle of cables at the rear. The charcoal grey system and disk boxes are only 2.5 inches high and a foot wide; the keyboard, 5 inches wider, is a wedge 1.5 inches high at the back sloping to half an inch at the front.

Inside the so-called "computing module" is a fast 80186 CPU, with either 128K or 256K of working memory, expandable to 512K. The choice of processor is a mixed blessing. The 80186 is only semi-compatible with PC programs—a slight handicap in the IBM-dominated microcomputer market. In compensation, it is considerably more powerful than the IBM's 8088. However, virtually none of the software now on the market takes advantage of this power. Unless you write your own programs, it will be quite some time before the 80186 provides any benefit an 8088 or 8086 machine could not have given. One obvious purpose for the 80186 is to support multiuser processing. With only one parallel and two serial ports, though, the MAD is clearly meant for individual use.

Other hardware features include two double-sided, double-density disk drives that store up to 360,000 bytes under MS-DOS 2.0, a combined monochrome and color graphics adapter, and a builtin clock/calendar. A single expansion slot can be occupied by a high-res monochrome graphics adapter, hard disk controller, internal modem, or memory board to bring the machine's total workspace to 704K. If this is not enough, MAD offers an expansion box to add extra slots.

Aesthetics aside, the keyboard is one of the design's best points. Its low profile, convenient slant, and builtin palm rests could add several words per minute to your peak typing speed. The ten IBM-compatible function keys are arrayed in two groups

of five above the alphanumeric keys. There are, however, two small flaws. There are no separate arrow keys; instead this function is superimposed on the number pad. And the sound. Audio feedback to confirm your keystrokes is a fine idea, but this keyboard sounds like a town-full of children squeezing those frog-shaped Halloween clickers. In fairness, after a few minutes it is not terribly distracting.

The 12-inch amber monitor is clear and easy on the eyes. It's closer to a true amber than most, not the bright yellow or international orange sometimes seen. An antiglare mesh covers the monitor's face, with mixed results. The mesh does cut down on glare from windows and lights, but it also makes the image just slightly fuzzy, with a slight amber halo around each character. When a distracting smear somehow appeared on the screen, behind the mesh, it proved necessary to dismantle the monitor in order to polish the glass. This happened only once in several months of use.

Measured against experience with five competitors in the approximately IBM-compatible market, the MAD comes out quite well. Even without the potential benefits of the 80186, programs clearly run faster on this machine than most. Its disk drives seem slower than most, but this may be a subjective phenomenon caused by expectations of high performance; limited testing did not confirm any real delay. Compatibility with the IBM is not as complete as with, say, a Columbia or Compaq, but it clearly goes deeper than simply running MS-DOS. While *Lotus 1-2-3* for the IBM does not run yet—MAD is working on it—the "flash" version of *WordPerfect* does, though the word processor's manufacturer warns that it is unlikely to work with anything but a PC.

MAD has worked hard to make this an easy machine to set up and use. The five cables that connect the components and the power cable use different fittings; there is no way to plug together the wrong parts. The user's guide is clear and accessible to beginners without the nauseatingly cute condensation that mars many such attempts. Hackers are likely to wish for more technical detail, but others will probably find this manual and the MS-DOS reference guide suits them well.

In all, if you need a serious business computer and do not require absolute IBM compatibility the MAD 1 seems a good choice. It works well, and its neat, compact package can occupy part of a desk without unduly cluttering an office. And there is a good chance that in another year or two software will come along to take advantage of the 80186. MAD owners will be ready for it.

MAD Computer, dual floppy disk model \$4,195; 10 mega-byte hard disk model \$6,295

PINNACLE

If you have not yet read the review of the Sage IV, it might be best to do so. As a program development system, particularly for those working in Pascal, or as the engine of a custom computer system, it has few rivals. But the praise that machine earns applies equally to the Pinnacle. This computer was designed a year later, and its producers had the Sage as an example of how good a computer in this class can be. They made the best of their advantage.

In many ways, the two are almost the same machine. The Sage is based on the powerful Motorola 68000 microprocessor; the Pinnacle uses the 68K processor. The Sage offers up to a megabyte of RAM; the Pinnacle comes with a megabyte of RAM. The larger Sage systems provide a double-sided, double-density floppy disk and a hard disk; the large Pinnacle system has a double-sided, double-density floppy and a 10MB Winchester disk. Like the Sage, the Pinnacle requires a serial terminal. And so on.

In fact, there are only two significant hardware differences between the two models: First, the Pinnacle offers a built-in real-time clock with a battery back-up. This clock automatically keeps track of the date and time of day. In particular, the operating system automatically knows the date so that it is no longer necessary to set it at the start of each day's work session. On the Sage, you would have to tie up a serial port with an external clock, such as the Hayes Chronograph, to achieve the same effect.

In addition, the Pinnacle lacks an IEE 488 bus interface. As partial compensation, the hard-disk Pinnacle offers a parallel printer port and no fewer than seven serial ports. However, virtually all modern instrumentation systems, such as those used in scientific laboratories, require this interface, and its absence makes the Pinnacle useless in the lab. For use in collecting and analyzing technical data, the Sage clearly has the edge.

The Pinnacle's chosen operating system is the UCSD p-System, licensed from Softech Microsystems. The firm plans to offer CP/M-68K, UNIX, and FORTH as well, but these were not available at the time of testing. The review unit also came with compilers for UCSD Pascal, Fortran IV running under the p-System, and a comprehensive set-up and configuration program known as *UTIL*.

Available for almost every microcomputer and

most minis as well, the p-System enables Pinnacle owners to trade programs with nearly any other computer they are likely to encounter. Data disks may also be exchanged, as the system reads any of ten different formats on its floppy disk drive. These include the Pinnacle's own formats, two formats used on the Sage, the IBM PC's single- and double-sided formats, three formats used by Network Consulting's version of the p-System for the IBM PC, and Softech's universal format for p-System computers. Only six of these standards can be used to format a new disk, however—the Pinnacle's own and those from the Sage.

One flaw in Pinnacle's version of the p-System has appeared: When you press the "reset" button, a bootable disk must be in the floppy drive. There are many occasions when you want to reset the system: when a program crashes, when you attempt an interminably long operation, such as searching for bad sectors on a disk that proves to have the wrong format, and so on. At these times, you must remove the program or data disk from the floppy drive and insert one that carries the p-System. The obvious solution is to put the system on all your disks, but it would be far easier to set up the machine so that it can boot from the hard disk if you wish.

Where the Pinnacle excels is in its speed. Using a 12 MHz clock, its processor runs half again as fast as that of the Sage, already one of the fastest micros available. This is supplemented by the ability to set aside part of the Pinnacle's memory as a disk emulator. Because this simulated disk operates at the speed of RAM, without the mechanical delays of a real disk drive, it greatly speeds operations that must often exchange data between the working memory and a disk.

Two speed benchmarks were run on compilations of Tom Swan's Pascal Data Base System—the same tests used to evaluate the Sage. When the system's 28 programs were compiled using the hard disk alone, the process ran at a rate of 1,830 lines per minute, more than double the Sage's hard-disk rate. When the disk emulator was used, the compilation ran at an astonishing 2,433 lines per minute. During the 5 minutes and 46 seconds it took to compile the programs using the disk emulator, it seemed that the system could have run even faster if it had not been forced to display a single " " on the terminal as a progress report after each line was compiled. This is quite extraordinary.

This astonishing speed makes the Pinnacle a good candidate for use in a multi-terminal time-sharing system. The *UTIL* program makes it relatively easy to set up a multi-user system—not a job

for beginners, but something that moderately experienced computer users should be able to tackle without trouble. This, too, is an advantage over the Sage, which requires considerable effort to configure for more than one user.

A small defect, but perhaps the worst in the Pinnacle system, is its documentation. While a large quantity of standard p-System manuals from Softech Microsystems is supplied, the machine itself comes with only a single 109-page manual. Of this, fully 38 pages is devoted to *UTIL*. The manual is well organized, however, and includes all the information likely to be needed by anyone experienced with the p-System.

In all, this is a state-of-the-art microcomputer. Its advantages over the Sage seem unlikely to last. Sage, too, can produce a multi-user configuration program like *UTIL*, and it will surely occur to them to use the 12 MHz processor. But for the moment, the Pinnacle is clearly the system to beat. It will remain as powerful a micro as you can buy for some time to come.

Pinnacle Systems, \$3,995

SAGE IV

When you talk about the Sage, you are talking about power, sheer brute force in a small package. If the Commodore 64 is the Chevette of computers and the IBM is the Cadillac, then the Sage is the lovely old AC Cobra with the 425 cubic-inch engine—compact, sleek, and almighty fast. Like the Cobra, it's far more machine than most of us really need, but it soon earns the love of those who use it.

The Sage computers are powered by the Motorola 68000 microprocessor, arguably the most potent chip now in production. Running at the Sage's 8 MHz clock speed, it is something over half as powerful as a VAX, a very respectable minicomputer. The standard Sage IV comes with 640K of working memory, expandable to a full megabyte. The base model comes with a choice of 40-track or 80-track double-sided, double-density floppy disk drive; another can be added, and options include up to 200MB of hard-disk storage.

The Sage does not come with built-in video electronics; instead it must be used with a serial terminal. The standard console is a Freedom 1000, built by Liberty Electronics, which comes with a Sage IV logo. In addition to the terminal port, standard interfaces include an RS-232 modem port, parallel printer port, four auxiliary RS-232 ports, and an IEEE 488 bus port. Many laboratory instruments use the IEEE 488 bus, and inclusion of this port

makes the Sage a good choice for collection and analysis of scientific data.

A Sage system is small; the Sage IV processor box is only 12.5 inches wide by 6.4 inches high by 16.8 inches deep. The Freedom 1000 terminal has a monitor measuring 13.3 inches high by 14.7 inches wide by 14.4 inches deep monitor, with a detached keyboard measuring 3 inches high by 17.6 inches wide by 8 inches deep. Any number of systems take up more desk space than that.

For an operating system, Sage has chosen the p-System from Softech Microsystems. This is a general purpose, machine-independent operating system with about as much compatibility as you can find. Versions of the p-System are available for every major small computer system, and for minis as well. Programs running under the p-System can even be transported to mainframe computers with minimal fuss. The review unit came with a variety of software: UCSD Pascal version IV.1 compiler; all normal p-System version IV.1 components; a comprehensive set-up and configuration program, *SAGE4UTIL*; Timberline Software spreadsheet package; and the *WORD/7* text processing system.

Because the Sage is most likely to appeal to programmers and to suppliers of custom computer systems, it was also run with a number of programs that would be of interest to professionals. These included:

A microprocessor cross-assembler program, recently developed by North American Technology, Inc., under UCSD Pascal version IV on an IBM PC/XT. This cross assembler was run directly as the IBM turned it out. A 2000-line test assembly was then run and demonstrated successful operation.

The Volition Systems "ASE" (Advanced Systems Editor) was borrowed as a p-System code file from a Network Consulting, Inc., (NCI) release for the IBM PC/XT, where it is called "Advance 1.0." The Advance System Editor is an extremely long and complex program. The NCI version of ASE has been used extensively on the Sage IV as part of this review. It behaves exactly like the original Volition Systems versions used on Apple II, Apple IIe, Western Digital Microengineer, and IBM PC computers.

The MODULA software of Volition Systems, including a preliminary copy of the latest version of the ASE editor.

As a test of the Sage IV's compatibility with other computers running the p-System, the Pascal Data Base System by Tom Swan was compiled and run. In 14,030 lines of compiled code, adapting the IBM version of this software to the Sage IV version of the p-System required changing fewer than ten lines of code to eliminate references to features of

the IBM PC's display. (This software, to be published in both text and disk form by Hayden Books in the second quarter of 1984, provides a complete Pascal-language relational database facility composed of over 30 programs.)

The computer was shipped for review with the operating system already in place on the hard disk, as well as on floppy-disk backup copies. Thus, the p-System is the recommended operating system for the nontechnical or first-time user of this system. Not everyone likes the p-System, however. To accommodate other requirements and preferences, Sage offers several other operating systems as well:

UNIX is a widely used, machine-independent operating system originally developed by AT&T. As a result of its long use internally at AT&T as well as at many universities, UNIX has quite a bit of software available. UNIX requires a powerful computer system, and the Sage IV has sufficient hardware resources to run UNIX quite well. UNIX is not for neophytes, however, just as one does not recommend a high-performance airplane to a pilot who has just soloed for the first time.

The IDRIS, PDOS, MBOS, and MIRAGE operating systems are also available from Sage Computer Technology. The FORTH user environment is also available for the Sage IV as implemented in the "hyperFORTH" version. It is even possible to get CP/M-68K for the Sage machines, though it cannot wring all possible benefit from its uncommon power.

Somewhat surprisingly, given that the Sage is generally not for novices, it proved surprisingly simple to add a printer and other peripherals to the system. Sage's *SAGE4UTIL* program makes it easy to set every parameter of each peripheral port, then record them as the system default. Thus *SAGE4UTIL* was used to set up the data rate for the serial port used with the printer. This convenience is a far cry from the brain-knotting hassle of first-generation personal computers. *SAGE4UTIL* provides a flexible way to set up the system resources.

One of the main uses of *SAGE4UTIL* is to set the drive for one of the eight floppy-disk formats the machine can use. These include 40- and 80-track formats with storage capacities of up to 819K. These include two 80-track, double-sided formats, one from Sage itself, the other used by the NCI p-System. Others include 40-track, double-sided formats from Sage, NCI, and IBM; single-sided formats from NCI and IBM, and the Softech 35-track universal format for p-System machines.

Although eight formats can be read on 80-track drives, only the Sage IV and Network Consulting

formats can be written on 80-track drives. The widest floppy disk compatibility can be obtained by ordering a Sage IV with one 40-track and one 80-track drive as well as the hard disk. This large set of industry standard media formats enables the Sage IV to work with numerous operating systems and software products now available for the Motorola 68000.

Standard p-System operating system software supports use of most of the main memory as a semiconductor "RAMDISK" facility. This allows over 900K bytes to be used under the file system as if it were another floppy disk. Since semiconductor memory is entirely electronic, there are no mechanical delays of rotational and disk arm motion. Thus, the RAMDISK facility speeds up the performance considerably; programs that make heavy use of the disk can run as much as ten times faster, and sometimes even more.

The testing and use performed for this review only scratched the surface. A good subjective evaluation of the Sage is "wildfire" in the speed department. A less subjective verdict can be obtained by examining particular cases. Serious hackers will find them interesting enough to justify including them; others may wish to skip ahead a few paragraphs.

Two relative speed benchmarks were run on compilations of Tom Swan's Pascal Data Base System on the Sage IV. In each case, an "exec" file was used to automate compiling and then saving each of 28 programs in the Pascal Data Base System. The average speeds measured included the system overheads of several filing and saving operations as well as compilation times. The 28 programs compiled totalled 14,030 lines. This total includes redundant calls to library data definitions. No listing files were generated.

The first measurement was made for a complete system generation using the hard disk exclusively. In this case, the average compilation rate was nearly 900 lines per minute. The second test involved the same programs compiled with all "disk" operations performed using the semiconductor RAMDISK facility. In this second case, the system generation averaged over 1450 lines per minute. During the 9 minutes and 40 seconds it took for the RAMDISK compiles, the system's red/green LED busy/wait indicator never perceptibly dropped from the green busy state into the red wait state. This number is impressive, given the fact that much of the time was spent doing system operations in between compiles. For development of Pascal language software, the Sage IV is close to ideal from this point of view.

When using the ASE editor on the Sage IV under its RAMDISK environment, macro operations on large text files are reduced to a few seconds. By comparison, the same ASE operations on an 8-bit first-generation personal computer—say, Apple II+—take many minutes to complete. For this kind of use, the professional who spends hours per day at the terminal could well save a significant percentage of his working life simply by using the Sage.

The Sage's extreme speed makes it a good choice for multi-user systems running under the p-System, and its six serial ports can be configured to work with separate terminals. However, setting up a multi-user system with the Sage is a complicated and not particularly interactive process. It should be undertaken only by someone who has considerable experience with the p-System.

In all these tests, over a period of about four months, the Sage performed reliably, doing all that was asked of it more quickly than almost any other machine could have. Clearly, this is not the system for everyone. Computer users whose machines spend most of their time processing text or manipulating small spreadsheets do not need this much power. Nor are they likely to spend the time it takes to learn enough about computing to gain the benefits that the Sage offers. But for professional programmers, particularly those working in Pascal, and for those who design custom computer systems and need a basic machine to customize, it's hard to beat the Sage.

Sage Computer Technology, \$7,900 with 640K RAM and 18MB hard disk; expansion to 1MB memory \$1,500; Sage Terminal \$590; Program development package (Pascal compiler and 68000 assembler) \$375; Timberline spreadsheet \$390

SPERRY PERSONAL COMPUTERS

Sperry's Univac division provides one of the few alternatives to IBM and its imitators in the large-computer market. You might expect Sperry to provide a true alternative in the personal-computer market too, but you would be wrong. Deciding that discretion is the better part of valor, Sperry has chosen instead to market an IBM PC compatible, the Sperry Personal Computer. It's manufactured by Mitsubishi of Japan and is relying on enhancements and better value to win its share of the market.

The Sperry Personal Computer doesn't look as much like an IBM PC as some other imitators. It uses half-height disk drives stacked one above the other, and although the keyboard layout is the

same as the IBM's, the keyboard connection is on the front of the system unit, not on the back. Sperry does use the same memory organization, I/O bus, and graphics format as IBM. The two machines also share operating systems and have a functionally identical BIOS.

Your software will appreciate these similarities because they ensure familiar disk formats and commands at both the user-language and machine-interface levels. In fact, Sperry's salespeople claim their machine is the most compatible of the IBM clones. They have yet to find a commercial package or public-domain program for the PC that will not run on their computer.

Of course, if it were providing only IBM compatibility, Sperry would be a late entry in a very crowded market. To make its personal computer stand out, Sperry provides several substantial improvements. Each model comes with 128K RAM, a serial port, a battery-powered clock/calendar, and at least one double-sided, double-density floppy-disk drive. More expensive models add a second floppy or a 10 Mbyte hard disk. MS-DOS and GW-BASIC are standard, as are complete software documentation and a hefty guide to operations, which explains the computer itself. In effect, Sperry starts with the most popular accessories as standard equipment.

All models also start with seven expansion slots. One will be filled by the floppy-disk controller. On hard-disk models, the Winchester controller fills another. The monochrome display adapter (including a printer interface) takes another slot, and the color-graphics adapter takes two. Remaining slots can be used for a printer interface, a memory board (allowing the basic memory to be expanded to 640K), and communications interfaces that enable the computer to emulate Sperry's UNISCOPE or IBM's SNA 3270 terminals. Any expansion board made for the IBM PCX can be installed in the Sperry PC, but simple arithmetic shows that a hard-disk model with graphics, memory expansion, and a printer interface doesn't have much room for user options.

You can resolve that dilemma by installing multipurpose boards from other manufacturers, but use caution. The clock/calendar and serial port those boards provide are already in the basic system, and the memory may not be compatible with one of Sperry's most striking innovations. Sperry has selected a fast version of the 8088 processor and provides the unique capability to change its clock speed. 4.77 MHz is standard and included for compatibility with other MS-DOS machines. With the flip of a switch, however the clock jumps to 7.16

MHz, allowing many programs to run over 50 percent faster. To make this feature work, the chips used for the memory must be top quality and rated for 150-nanosecond operation. Boards that are intended for the standard clock speed may well contain less expensive, slower chips.

The type of memory chip installed may also affect the usability of aftermarket display adapters, but Sperry's offerings are so good that you are unlikely to need them. The company's monochrome adapter is a simple imitation of the IBKM product and is offered in Sperry's low-cost systems. In contrast, the Sperry color-graphics adapter is what IBM should have made. It supports all the modes used by IBM software, but builds on them to provide a state-of-the-art display. Using 192K of dedicated memory, it can produce 640 by 400 pixel displays using any 16 of 256 possible colors. In 320 by 200 pixel mode, all 256 colors can be used simultaneously. This display makes color a working tool, not just an attention-getting gimmick.

To use such hardware, you need software support, and Sperry provides it. There are programs to support terminal-emulation hardware, and two software libraries exist (one for general-purpose plotting and another for business graphics) that make use of Sperry's extended color-graphics display. Dealers will also have a list of the IBM PC software that has actually been tested on the Sperry machine and will offer some of the more popular packages directly. The current brochure includes *Multiplan*, *WordStar*, *dBASE*, and *Peachtree* accounting programs.

It is support like this that attracted many personal-computer buyers to the IBM PC. They knew it was backed by the company's extensive experience and solid reputation. Now these people have a choice. Sperry's background in computers is equally as impressive as IBM's, and although the Sperry personal computer is manufactured by another company, they can expect the level of workmanship in hardware, software, and documentation to be high. They won't be disappointed.

Sperry, hard disk (monochrome) \$5,099; (color) \$5,753; one floppy drive \$2,643; two floppy drives \$3,119; memory expansion units \$301 (for each 128K up to a total of 640K)

VECTOR 4-S

The first thing you're likely to notice about this system is its good looks. The Vector 4-S comes in two pieces: a detached keyboard, and a futuristic-looking beige box complete with a 12-inch green-

screen monitor hiding behind a smoke-glass front. Two generations beyond its Vector 3 ancestor, the 4-S draws heavily on the design of the original Vector 4 series, while adding a few noteworthy features of its own.

How valuable those features will turn out to be is another question. For several years now, Vector's computers have appeared to be the work of first-rate engineers handicapped by poor marketing decisions. The 4-S follows this unfortunate trend. Yet the hardware itself remains of such high quality that it deserves a look from anyone who needs a serious business machine.

The basic 4-S comes with 128K RAM, the 12-inch green-screen monitor, and dual floppy disk drives with a hefty 700K storage capacity per disk. Remove the beige cover, and you will find a 12 amp power supply, a small speaker, a not-quite S-100 card cage, and, of course, the system electronics.

The card cage deserves special mention, if only because it is a bit strange. It looks very much as if it uses the S-100 bus structure, but it doesn't, quite. At one time, Vector computers used an honest-to-goodness S-100 bus. For some reason, though starting with the Vector 4, the company switched to a modified S-100 structure, the V-100. This supports only a fraction of the standard S-100 signals, and only a fraction of the available S-100 boards.

The Vector 4-S has three V-100 slots. One of these is used by the disk-controller card. The other two are theoretically available for expansion, if you can find suitable cards to work in them. In practice, what you get may be the extra bulk and cost of a bus-structured computer with little of the effective expandability.

The power supply also has problems. Vector's machines once came with a heavy-duty power supply that was well protected against power surges and other interference from the electric lines. No longer. Though the 4-S should work well for most users, those with "dirty" power lines are likely to need an external filter to protect the system.

Most of the system electronics, including the first 128K of RAM, are contained on the SBC, or single board computer at the back of the box. An optional RAM board with an additional 128K block of memory is available to mount piggy-back on the SBC board, for a total of 256K.

The Vector 4-S is a dual-processor computer, with both a Z80B and an 8088. The Z-80 chip lets the machine run CP/M-80, and with it, most programs that run under CP/M. The 8088 chip lets the machine run both CP/M-86 and MS-DOS, and the various programs that use these operating systems.

Graphics on the 4-S are impressive, as they were on the Vector 4. The system offers three levels of resolution: 640 by 312 with no grey scale; 320 by 312 with four shades of grey; or 160 by 312 with 16 shades of grey. Color is also available, with four or 16 colors instead of shades of grey, but Vector treats the machine's color capability almost as an afterthought. Another obstacle is that Vector Graphic's recommended high-resolution color monitor is roughly twice the cost of the IBM color monitor. Graphics support is limited to the popular Digital Research GSX graphics utility, some modules of which Digital has recently announced it will not produce.

The character set on the screen is at least as impressive as the graphics. The numbers and letters are formed in a 16 by 13 dot matrix. This produces a superior display, with characters that are crisp, and eminently readable. Early Vector 4s had a problem with screen waviness, but this has been fixed by properly shielding the power supply. It is not a problem in the 4-S.

Built into the 4-S is a sound generator that really merits attention. Whole fugues and sonatas have blared from the tiny 2-inch speaker on this machine, thanks to an unofficial, unapproved, and aborted attempt to create a demonstration program for this feature. Unfortunately, Vector seems almost ashamed of this computer's ability to produce sound, and has provided virtually no support for it—unless you count a few pages of documentation detailing the correct machine-language approach to creating sound.

The rear panel of the 4-S is a trainyard of connectors for input and output devices. There are two serial connectors, one designated as a communications port, the other as a printer port. You will also find a Centronics-compatible printer port, a Qume-compatible parallel data interchange port, and a port for the Aydin high-resolution color monitor that Vector recommends.

The keyboard on the 4-S has 91 keys. These include a Help key and 15 programmable function keys across the top row. You can define any of the function keys in any way you like. This means that in a program like *WordStar* you can use a single keystroke to save a file to disk and return the cursor to where you started. To do this manually in *Wordstar*, you must enter Control-KS, wait for the file to be saved, then enter Control-QP. With the programmed function key, you hit the key, then go make a cup of coffee. When you come back, the file will be saved, and the cursor will be waiting for you where you left off.

Superficially, a dual-processor computer that

uses both CP/M and MS-DOS seems like the best of both worlds, but there are some serious limitations. If you are using the standard dual floppy version of the 4-S, there are few problems, and you can switch between the 8-bit and 16-bit operating systems at will. If you have opted for a hard disk on your Vector, however, whether the 5-, 10-, or 40-megabyte version, caution and careful planning are called for.

As you would expect, the hard-disk version of the Vector is generally booted from the hard disk. This can be installed in any one of four ways: with CP/M-80 only, with CP/M-86 only, with MS-DOS only, or with both CP/M-86 and MS-DOS. If you've picked any of the first three options, then when you turn the 4-S on, the system reads the disk and boots up accordingly. If you pick the fourth option, the computer starts by asking you which operating system to use, and then boots up as ordered. All this sounds as though it should work out swimmingly. Unfortunately, nature and Murphy's law side with the hidden flaw.

CP/M-80 cannot co-exist on the hard disk with either 16-bit operating system. This means that if you set the hard disk up with either MS-DOS or CP/M-86, there is no way to get into CP/M-80 from the hard disk. The Vector will let you boot from the floppy, and get you into CP/M-80 that way, but if you boot from the floppy, you have no way to get information to or from the hard disk, and have effectively transformed your 4-S into a single-drive computer.

Vector has gotten around this by giving you a way to run eight-bit programs even in a 16-bit environment. They've done this by providing a CP/M-80 emulation utility called Run8. Run8 still has some limitations. To use it, the utility must be on the same disk drive that you are logged on to. Also, this extra interpretation step can cause problems with a very small number of programs. Even so, most appear to run without problems.

The second complication is more troublesome. If you set up the machine originally with two operating systems on the hard disk, you'll have no problems. When you install them, the computer reserves separate segments of the disk for each operating system, effectively setting up the machine as if it had two hard disks—one devoted to each operating system.

The problem shows up if you start out with CP/M-86 only or MS-DOS only, then decide you want to add the other later. Installation is simple, but you'll have to start by erasing the hard disk. Then you go back to scratch, put both operating systems on the disk, and reformat the disk.

This doesn't seem like it should be a problem. After all, formatting a 5-megabyte hard disk only takes about 18 minutes. Others take proportionately longer, but not enough to require an excessive investment in time. The problem is that you must store your files somewhere while formatting, and Vector's backup utility will work only with files that have seven letters or fewer in their name (not including the extension). If you've used all eight letters the operating systems allow, the Vector backup utility will ignore the files, forcing you to copy them over one by one.

The floppy disks on the Vector 4-S deserve a close look also. Vector Graphic used to assume that Vector owners would want to upgrade to the company's new machines. Therefore, they took special care to make sure that program and data disks from old models could be transferred to new ones. Its hard-sectored disks were something of an oddity, but they held impressive quantities of data and new machines could read and write disks from old ones.

No longer. Vector has now switched to soft-sectored drives that hold an extra 97K per floppy and even have a quasi-compatibility with the IBM PC. Although the 4-S cannot format disks for the IBM, it can read from and write to them if they have been formatted on another machine. All this is very nice, but in making this switch Vector has thrown away seven years of compatibility with its own equipment in order to pander to the current favorite. The Vector 4-S can neither read nor write the hard-sectored floppies used on earlier Vectors.

What all this means is that if you have a Vector 3 or 4, and want to use your data on a 4-S, you cannot simply take the disk and place it in the new machine. You can transfer the file electronically, of course, but there are a few complications.

Vector provides a program called *Exchange* for just this purpose. *Exchange* is free with the 4-S and \$25 for older Vector 4s. Theoretically, all you have to do is attach a cable between two machines and use *Exchange* to transfer your files. Unfortunately, *Exchange* is a CP/M-86 program; if you own a Vector 3, which is strictly an eight-bit machine, you have to start by finding a Vector 4 set up with CP/M-86. Then you can take your Vector 3 disks, insert them in the Vector 4, and transfer them to the Vector 4-S from there.

If you have a long file, there is good chance that the transfer won't work. Apparently, there are timing differences between the 4 and the 4-S that *Exchange* does not take into account. Every once in a while, one side or the other loses track of what's going on. This becomes evident when, after five

minutes of exchanging the file, the program stops and an error message appears on the screen.

The solution, of course, is to transfer files with a good communications program. Then you can even ship them directly from your Vector 3. Note that you might as well throw out *Exchange*. Vector has a long history of this sort of nonsense.

All told, the Vector 4-S is unquestionably an outstanding piece of hardware. Its only important oversight is that it has no provision to add the 16-bit 8087 math coprocessor. The bad news is that Vector Graphic seems to be fumbling in its marketing and support of the machine. The excellent

sound and graphics, for example, deserve an emphasis they are just not getting.

As good as this machine is, keep in mind that the firm's dealer base is shrinking, and so is the Vector staff. This does not make for good support when you run into trouble. If you buy the Vector 4-S, you may soon find yourself with a terrific machine, but completely on your own. If that doesn't bother you, then you can't afford to pass this machine by.

Vector Graphic, Vector 4-20-S \$3,995; Vector 4-30-S \$4,995; Vector 4-40-S \$5,995

PORTABLE COMPUTERS

APPLE IIc

The Apple IIc is the newest addition to the Apple II family of computers. The IIc is a nearly perfect machine for computer novices who want the power and software availability of the Apple II family, but don't need infinite expandability.

There are two major differences between the IIc and its 8-bit predecessors. The first is portability. The second is its lack of expansion slots. To achieve portability, Apple sacrificed the expansion slots that made the Apple II family popular; however, all the peripheral expansions that most users need are built in as standard features in the IIc. The sleek off-white case of the IIc contains 128K of RAM, two serial interface ports for printer and/or modem, an 80-column display, a mouse interface, a built-in 5¼-inch disk drive with an external connector for a second drive, and a cute handle that doubles as a stand.

What does this mean for the average computer user? Everything that you would want to connect to your computer has been thought of, and the necessary interfaces have been built in. The lack of expansion slots may disappoint hard-core hackers and those with specialized needs, but for the rest of us the IIc should be fine just as it comes from the box. Since the Apple IIc is very similar to its non-portable sibling, the Apple IIe, this review will stress the differences between the two machines as well as some special features of the IIc.

The Apple IIc is quite portable. It weighs about seven pounds; however, that does not include the external power supply (2 to 3 pounds) or a display device. Apple has designed a beautiful nine-inch high-resolution, green-screen monitor to complement the IIc. It has a tilt stand that holds the monitor over the IIc, and this creates a convenient and attractive combination. At the time of this review, Apple's flat liquid-crystal display and battery pack—though prominent in the computer magazines—are not yet available; the IIc and monitor are temporarily tied to the wall by an AC umbilical cord. Thus in the portability race the IIc takes second place after the lap models from Radio Shack, NEC, and others. You should remember that it has a built-in disk drive. This disk drive accounts for its larger size, but this allows for compatibility with an enormous body of software. Most disk-equipped portables lie at the other end of the portable spectrum—the “luggables,” which are at least three times heavier than the IIc.

Another change in the IIc from previous models is the keyboard. The new keyboard contains full-size keys and can generate any standard ASCII

code, just like the IIe, but it has an unusual feel and sound. The keys on the IIc are nothing like the IBM PCjr's “chicklet” keys, which are not useful for serious work. The IIc's keys did not seem objectionable, but each user should evaluate the keyboard before buying this or any other computer. For those in the crowd who don't like the standard typewriter keyboard layout, there is a switch in the IIc: It converts the keyboard to a Dvorak layout, which allows faster typing.

Some of the unique features of the IIc are its new microprocessor, a standard 128K of memory, and built-in mouse interface. (Warning: The surgeon general has suggested that if you are not a computer hacker, then you should just skim this paragraph.) The Apple IIc contains a 65C02 chip, a new low-power version of the 6502 chip used in the Apple II family. The 65C02 has an extended instruction set which is completely compatible with its predecessor; however, software that uses undocumented instructions that existed in the 6502—a fraction of a percent of all software—will not run on the IIc. The converse of this situation is that making use of the extended instruction set of the 65C02 will not make it possible to write software for the IIc which is faster, but will not run on any other Apples.

Apple claims that the IIc is compatible with between 90 and 95 percent of existing software. Problems will arise with any program that attempts to access an accessory slot that is not present, as well as some copy-protected software that uses ROM or disk protection schemes. The ROM in the IIc has been completely rewritten to allow for the inclusion of some new mouse routines, but all standard entry points used on previous Apples have been retained in order to maintain compatibility. If you are concerned about whether your favorite program will run on the IIc, call the manufacturer or try it at a dealer.

Since the IIc comes standard with 128K of memory, a double hi-res graphics mode with 560 x 192 pixels is available. This is in addition to the standard hi-res mode, 280 x 192 pixels, and low-resolution graphics mode—48 x 40 pixels. The double hi-res mode was available on the Apple IIe with 128K, but because it was not the standard configuration little software was developed for it. Now that the IIc is equipped for this type of display, there should be some new programs which support this mode with spectacular graphics.

What is a mouse? Not a small furry rodent when it is connected to an Apple. It is a hand-held device that lets you move the cursor on the screen by roll-

ing the mouse on a flat surface—most likely your desk. When you purchase a mouse for your IIc, it is about \$75 cheaper than the mice for the other Apples. This is because the interface for the mouse is built into the IIc. With your mouse, you also get *Mouse Paint* software. *Mouse Paint* is a drawing program that lets you use the mouse to create fantastic graphics on the Apple's hi-res screen and print them on Apple's Imagewriter dot-matrix printer. The similarity between *Mouse Paint* and Apple's *MacPaint* for the Macintosh is amazing. It is clear that Apple is committed to the mouse as an input device, as it is used by the Lisa and Macintosh. They have even included some standard mouse routines and *Mousetext* in the new ROM. This will encourage independent software developers to include mouse input with their software. An example of this is *Jane*, a do-everything combination program for the IIc, which uses the mouse to select applications or text, just like Macintosh or Lisa programs.

If you were lost in the previous discussion of 65C02s and pixels, then relax, because the Apple IIc was designed for the novice user. It is a snap to set up, with step-by-step pictures for each procedure. The documentation is very slick and slightly superficial; however, it was designed for those who will only use pre-written software and it fits their needs well. If you are a programmer or hacker, then you will be disappointed by the lack of in-depth manuals, a trend Apple started with the Apple IIe.

Included with the Apple IIc is a pack of demonstration disks and a system utility disk. The system utility is a masterpiece of powerful but friendly software that allows computer novices to harness the power of Apple's disk operating systems (DOS 3.3, PRODOS, and the UCSD p-System). It contains on-line help and many warnings at every step of the way, and it easily performs operations that might panic beginners—formatting disks, copying files, or just getting a catalog of a disk. The utility will automatically determine whether a disk is DOS 3.3, PRODOS, or p-System and then produce a catalog or transfer files between different operating systems. The demos included are a computerized introduction to the IIc, samples of BASIC and LOGD programs, and *Appleworks*, Apple's answer to *Lotus 1-2-3*. *Appleworks* is a combination word processor, spreadsheet, and database program that runs on the IIc or IIe. If you are planning to use *Appleworks*, then you should get the external disk drive.

Just what can't the Apple IIc do? Because it has no slots, there is no room for CP/M cards, clock/calendar cards, the ProFile hard-disk drive, or left-

handed English toaster interface cards. For those of you who insist on using *WordStar*, time/date stamping your files, storing every recipe in the world on a hard disk, or having your muffins perfectly toasted by an Apple, then you will have to buy an Apple IIe. For everyone else, the IIc is a good choice.

The Apple IIc is an excellent addition to the Apple family of computers. It is well made and contains many enhancements over previous models, yet still retains the large base of software that has made Apples so popular. It will satisfy the needs of home users, students, and anyone that needs a portable computer but does not require compatibility with a CP/M or MS-DOS machine at the office.

Apple Computer, \$1,299; monitor IIc \$199; mouse \$99

CHAMELEON

Like its namesake, this personal computer exhibits changing characteristics. On the positive side, it offers state-of-the-art memory, disk drives, data communications, and a powerful dual-processor architecture. On the negative, it requires significant experience with small computers to use it effectively. This machine can use more standard software than any other on the market, but because the manufacturer doesn't provide the specialized software, documentation, and support that the average computer owner needs, their market is effectively limited to the sophisticated user.

The Chameleon, you see, is really two computers. Insert an disk containing MS-DOS and it is a 16-bit computer roughly compatible with the IBM-PC. Insert a disk with CPM-80, and it becomes an eight-bit computer able to run even more software. Unfortunately, not all programs written for the IBM will run on the Chameleon, and CPM-80 programs must be supplied in a special format. There are portables with greater compatibility with the IBM PC, and CPM-80 machines that are easier to use, but if you can use both capabilities in the same machine, the Chameleon may be for you.

Seequa offers the Chameleon in two models, a base model and the Chameleon Plus. The Plus adds internal options to the base model; they look identical. Both come in 16 by 18 by 8 inch tan metal cases and weigh 28 pounds. The standard configuration includes a keyboard, two single-sided disk drives, a 9-inch display, parallel and serial ports, and 128K bytes of memory, expandable to 256K. The Plus includes the extra memory and uses double sided drives. Unlike many IBM compatibles, the

Chameleon does not have expansion slots for IBM-style accessories. Seequa-built communications or IEEE control options can be installed, but this work (and memory expansion on the base model) must be done by a dealer. There is really nothing an average owner can do to expand his or her Chameleon.

The basic construction of the Chameleon is sound, but some details leave a little to be desired. Electrical connections for power, the keyboard, and a printer are covered by a little door that must be opened by twisting a screw. A dime can be used in place of a screwdriver but no tool should be required. The handle is another problem. It is a curved metal bar connected to each side of the case; it swings up to help you carry the Chameleon or down to support it at a convenient viewing angle. The dual purpose is clever, but the bar hurts your hand after carrying the Chameleon for a few minutes, and it scratches furniture when the computer is used.

To use the Chameleon, you swing the handle down and release a catch at each side. This separates the keyboard that covers the display and disk drives when you are travelling. The keyboard uses the IBM PC layout, but the keys feel slightly smaller and have less travel. Key presses are signalled by a faint beep from the system's speaker, and both the Caps-Lock and Num-Lock keys have LEDs to indicate their state. The display is functionally equivalent to the IBM PC's graphics adapter but does not display color without an external RGB monitor. Characters are surprising sharp. Disk drives are mounted vertically beside the display. Single-sided drives on a test model were noisy, but when they were replaced with double-sided drives, the Chameleon was as quiet as any comparable computer.

Packaged with the Chameleon are a spreadsheet program, a word processor, MS-DOS and *Microsoft BASIC*. Options include *GW-BASIC* (with graphics), CPM-80 and -86, and *Condor* database software. *GW-BASIC* and *Condor* are standard on the Chameleon Plus. The spread sheet and word processor software are *Perfect Calc* and *Perfect Writer*, with *Perfect Speller* included. They have been customized for IBM-compatible computers and come with tutorials that have been further customized for the Chameleon. The "Perfect" family of programs rank among the better ones in the industry, and can make the Chameleon productive as soon as you get it home.

Seequa has a project to test as many commercial MS-DOS and CPM-86 packages as possible so that dealers will know which ones run on the Chameleon. So far, it seems that almost all commercial

machine-language software written for the IBM PC will run on the Chameleon, but programs written in BASIC will probably not. The Chameleon can be used to write BASIC programs, but without the *GW-BASIC* option, it will not support advanced graphics, music, and communications commands. Chameleon owners need to try a program on their machines before they buy it and should be careful about buying mail-order software.

There is no similar project for CPM-80 programs. This is a shame, because the ability to use two sources of software is one of the Chameleon's strongest points. CPM-80 software must be recorded on disks in CPM-86 format before it can be tried on the Chameleon. At that point you can attempt to resolve any difficulties caused by the computer itself. Seequa does not provide utility programs to help in this process, nor does it sell prepackaged CPM-80 software. Clearly the 8-bit capabilities of the Chameleon are there for experienced users only.

The failure to capitalize on its features is the Chameleon's greatest shortcoming. For example, other computers have switches that must be set to tell them what options and how much memory are installed. The Chameleon has a special memory that can be programmed with this information and does not forget it when the machine is turned off. The same area can be used to direct printer or console data to other ports, something that must be reentered on other computers every time they are turned on or reset. This is an exciting asset, but it was completely undocumented on early models. Even on later models, the documentation and utilities that have been provided are not sufficient to inspire novices to use the feature.

It seems that the Chameleon's dual nature is not just a product of its two microprocessors, but also of its manufacturer's attitude. The Chameleon is attractively priced for people who just want to run commercial programs written for the IBM PC. It also provides unique capabilities for the experienced user. For anyone else, however, the lack of specific documentation and software support may be a source of unexpected problems.

Seequa Computer Co., \$1,995

COMMODORE SX-64

Shortly after the Commodore 64 made its first appearance, Commodore's Japanese design center debuted a portable version, the SX-64 (also known, at various times, as the SX-100 and the Executive 64). It took a long time to appear on the U.S. market, and even now it remains unclear just

how serious Commodore is about making a competitive product of this machine. But some people may find it appealing.

Radically different in appearance from the original, VIC-like model, the SX-64 resembles other transportable computers but manages to avoid looking like a portable sewing machine. It is very small—14.5 inches square by 5 inches tall; yet it weighs 27 pounds. It comes with a single floppy disk drive, with a recess above it to store a few disks for transport. A second drive can be added. The keyboard is full-size, built into a detachable lid. The monitor, which is covered by the keyboard for carrying, is a rarity among portables—a color screen. Though only 5 inches diagonally, it is crystal clear and better suited to displaying text than one might guess.

This new version of the 64 is fully compatible with the original and varies only slightly in function. The processor is the same 6510, the memory the same 64K. It provides the same 25-by-40 character text display and 320-by-200 graphics resolution. The built-in BASIC matches the original 64's. Any program that will run on a Commodore 64 will work with the SX-64 portable.

The differences, by contrast, are relatively small. Because of its built-in disk drive, there are no provisions for a data cassette recorder; the first program on a disk can be loaded automatically by pressing two keys on the keyboard. The keyboard, itself, is different. The keys have been reshaped and are now white instead of the 64's brown; they have a much better and more positive feel than the original keys. The cartridge port has been moved from the back of the machine to behind a sliding door on top of the case. Only one known peripheral, Commodore's 1650 auto-dial modem, does not fit the new physical layout. The SX-64 is a gem of industrial design.

One serious question about this machine has yet to be answered, however: How durable is it? The 1541 disk drive has proved to be less than reliable, even in stationary systems. With stress and wear, the shaft of the drive's stepper motor seems to rotate within a critical pulley part, throwing the drive out of alignment. It seems all too likely that the shocks faced by a portable computer would hasten this process, making the SX-64 too fallible for regular use. For the moment, of course, this is no more than speculation.

Just what buyers Commodore hopes to reach with the SX-64 remains unclear. It's an uncommonly dedicated video game fanatic who cannot bear to leave his computer behind, and it is hard to believe that *Pac Man* can be as much fun on a tiny

screen. This model could be Commodore's way to interest a new market—executives and small businesses—in the 64, which has primarily been a home, school and hobbyist machine. If so, it seems unlikely to succeed unless Commodore makes some changes. For business sales, the SX-64 needs two faster disk drives. And it needs better marketing, through business-oriented computer stores, with an emphasis on performance and support rather than low price. This has never been Commodore's strong point.

As this is written, however, the SX-64's market appeal hardly matters. It is still scarce, and its price is considerably more than the cost of individual components put together. Further, battery-powered lap portables at under ten pounds are quickly winning the market for mobile computers in this price range. Unless Commodore can change its course soon, the SX-64 may turn out to be a computer whose time never quite arrives.

None of this really counts against the machine itself, of course. If you like the Commodore 64 and want your computer system in a single, neat package badly enough to pay roughly \$250 more than you would for a 64 with a disk drive, the SX-64 is clearly the machine for you.

Commodore Business Machines, \$799

COMPAQ PORTABLE COMPUTER

COMPAQ Computer got its start in 1982, when three former Texas Instruments employees decided that there was room in the market for an IBM-compatible portable. The market agreed with them. Beginning with \$20,000, they managed to raise \$10 million in venture capital that September. By the end of 1983, they had sold some \$80 million worth of machines.

COMPAQ's portable will never be mistaken for a lap computer, but it is adequately mobile for an IBM-compatible system. It measures 20 inches wide, 8.5 inches high, and 16 inches deep when in operating position. It weighs about 28 pounds with one disk drive, about 33 pounds with two. It's housed in a durable Lexan case roughly the shape and appearance of a portable sewing machine and about as difficult to carry.

The standard, off-the-shelf unit houses the electronics and power supply, a cooling fan, 128K of memory, a keyboard, a 9-inch green display, one double-sided, double-density 320K disk drive, a parallel printer adapter, and color and monochrome video adapters. A recent addition to the line, the COMPAQ Plus, sports a 10MB hard disk as

well. The company even supplies an extra power fuse in a special fuse holder. The COMPAQ comes with its own disk operating system known as COMPAQ DOS 1.11, which is a derivative of Microsoft's MS-DOS 1.1.

The COMPAQ offers several extra-cost options. For superior number crunching, you can install an 8087 math processor next to the 8088. An additional 128K of memory fits on the main board, for a total of 256K. A second 320K disk drive also may be installed. Internal switches actually allow up to four drives in the system, but the other two must be external.

An IBM-compatible expansion bus has five slots for plug-in cards. One is used for the standard parallel interface. A second is taken by the video output card. That leaves three unused expansion slots for accessories.

While the single-drive 128K configuration may be adequate for many users, most prefer a 256K dual-drive system. Adding the extra RAM and disk drive are recommended, and are best done by the dealer at the time of purchase.

The video arrangement is clever. On an IBM PC, using a color monitor (necessary for certain programs) requires a special graphics card, at extra cost. With the COMPAQ, color outputs are converted to monochrome and displayed in shades of green. There's no need to worry about which video board is installed before running any piece of software. Nevertheless, the standard COMPAQ system already has connectors for both NTSC composite and high-resolution RGB color monitors.

For color displays, the RGB-style monitor is definitely recommended. The cheaper NTSC monitors may work for simple games and graphics, but poor resolution makes them virtually useless for text. The COMPAQ senses when a color monitor is installed and redirects output as needed—color to the color monitor and monochrome to the monochrome output.

The keyboard, which is permanently connected to the main chassis by a short, coiled cord, follows the aberrant layout used on the IBM PC. It lacks the mechanical clicks and overall feel of the PC keyboard, but an optional beep with each keypress provides feedback for those who want it. Furthermore, key heights, shapes, and sizes are slightly different; adapter kits that change or enlarge some IBM keys will not fit the COMPAQ.

When the COMPAQ is closed for transport, there are no parts sticking out. Fuse, power cord, interface connectors, brightness control, and other parts all are concealed inside protective covers, safe from accidental damage.

This machine is surprisingly compatible with the IBM, in both software and hardware. COMPAQ Computer Corporation lists more than 300 major software products known to be compatible with their unit, and those are just the ones they've specifically verified. Many others not listed will run equally well. In fact, it's hard to find a commercial program designed for the IBM PC that won't run on the COMPAQ.

The most notable difference is that the PC uses ROM-based Advanced BASIC or *BASICA*, while the COMPAQ uses disk-based *BASICA*. The COMPAQ can run *PC-DOS* 1.1, but not the *BASICA* that comes with it. However, nearly all programs written for the PC's *BASICA* work without problems under the COMPAQ's. In six months of testing, the only exception found has been the driving software for one particular plug-in modem card.

However, some commercial programs designed specifically for *PC-DOS* won't function under *COMPAQ DOS*. It is a good idea to buy *PC-DOS* with the COMPAQ, make a working copy with *COMPAQ BASIC* and *BASICA* files replacing the *PC BASIC* and *BASICA* files, and use that to boot *PC-DOS*-specific software. Running both *COMPAQ DOS* and *PC-DOS* interchangeably will eliminate most problems with later software purchases. If a given program doesn't operate correctly under *COMPAQ DOS*, it takes only a few seconds to switch to *PC-DOS*, probably solving the problem.

Such incompatibilities usually appear with programs that modify DOS itself. For example, software that provides in-memory print spoolers or memory disks often must alter DOS parameters. Most such programs fail when used with *COMPAQ DOS*.

Users so inclined may also run Digital Research CP/M-86 and UCSD p-System. Both are readily available and perform quite well on this computer.

Most expansion cards designed for the IBM PC work equally well in the COMPAQ. That includes interfaces, memory expansions, multifunction cards, plug-in direct-connect modems, and others. Of course, there are bound to be exceptions. One Z-80 coprocessor card has been a problem, but apparently due more to a bug in the accompanying software than to a board malfunction. All normal CP/M utilities functioned, but a special disk-to-disk copying program would not work on the COMPAQ.

The COMPAQ also seems limited in how much memory it can access. Charts of switch settings shown in a dealer's maintenance manual indicate that it should reach 640K, but actual tests of memory additions have been unable to reach higher than 512K. However, the board is said to be able to

accept 256K memory chips when they become available.

Yet this is still more compatibility with IBM PC boards than IBM's own Portable PC offers. In theory, expansion card for the IBM desktop computer should work in the portable; the problem is simply that relatively few of them will fit. Only one of the Portable PC's slots is full-length, and that is wedged in so tightly that many add-ins are too wide. Three others accept only 5.25-inch boards, and another requires shorter boards still. The last is supplied with power, interrupt, and control lines but no data-bit or address lines; just what it's for, no one knows. For PC-compatible expandability, the COMPAQ is the clear winner.

The most serious shortcoming is that the COMPAQ is not delivered with bundled software. The one diskette that comes with it furnishes BASIC, some DOS utilities, and a few demonstration programs, but nothing of practical value. Contrast this to some less expensive 8-bit computers marketed with software for word processing, data management, spreadsheets, and the like, and the COMPAQ is at a distinct disadvantage. Buyers must plan on spending up to several thousand dollars more than the machine price to obtain usable applications software. Without that expenditure, the COMPAQ is little more than useless.

Documentation doesn't live up to expectations. The system arrives with three manuals—an operations guide, a DOS reference guide, and a BASIC reference guide. They are no help at all when it comes time to add memory, reconfigure disk drives, plug in a modem, or make other changes to the machine. Nowhere is there any mention of the internal switch settings that may have to be reset. Nor is there any description of how to install or remove expansion cards, how to adjust the video display, or even how to open the outer case. Worse, there's no troubleshooting information. For anyone but rank novices, the manuals are miserable failures.

Despite the ability to reroute color displays to the monochrome screen, the video display has a bothersome weakness. COMPAQ uses a slow-recovery screen subject to excessive after-imaging. It takes five to ten seconds for an image to fade completely, so scrolling text and rapidly changing graphics screens quickly become almost unreadable. The previous image is still clear as the next appears, making it extraordinarily difficult to use this system for telecommunications, word processing, or other applications requiring moderate to high-speed screen updates. Graphics are worse, sometimes leaving three or more levels of varying intensity on the screen at one time.

There are a few mechanical problems, as well. The folding legs on the COMPAQ do not adequately raise and tilt the screen. Anyone attempting to use this computer on a conventional desk or table surface will quickly discover that they need some way to raise the computer and angle the screen toward eye level. Luckily, many computer stores are selling special stands that solve this problem without excessive cost.

Units tested also suffered problems with disk drives. In the first unit, the disk controller electronics failed within four hours. That computer was replaced in its entirety. The second unit suffered the same failure after three weeks, requiring replacement of the controller and both drives. In about five months since then, the new drives have operated reliably; they're obviously a different brand from the original drives.

The COMPAQ may not be best the machine for international travelers. Its power supply is a single-voltage device operates at 120 volts AC and 60 Hz. To use it overseas, you will need a converter for sources such as 220 volts, 50 Hz. COMPAQ does not supply one, so users will have to locate suitable converters on their own.

Despite its few problems, the COMPAQ can be an attractive alternative to the IBM PC. It will do almost everything that the PC will do, and generally at lower cost and with fewer extra-cost options than the PC. Plus, the COMPAQ has the advantage of being more easily transported.

COMPAQ Computer Corp., \$2995 with 128K RAM and one disk drive; second disk drive \$595; COMPAQ Plus \$4995; Hard disk upgrade kit \$2500

EAGLE SPIRIT SERIES

You had to give the Eagle representative full credit for honesty. Transportable rather than portable is the way he described the Spirit when first it was announced. He was right. This computer and the many similar ones on the market are about as portable as the portable TVs of the 1950s. So much for the slick color brochure with a picture of Mr. Executive boarding a Lear jet cheerfully toting his trusty Eagle Spirit over his shoulder. Somewhere off camera is a flunky carrying his briefcase, suitcase, and satchel full of software manuals.

The Eagle PC Spirit is a ready-to-run computer in a single package, about the size and shape of a portable sewing machine case. Essentially, it is an Eagle PC Plus but made transportable and with a builtin monitor. There are two Spirit models: the Spirit-2, with two slimline 360K floppy disk drives and the Spirit-XL, with one such drive and a 10MB

hard disk. The Spirit-2 weighs 30 pounds, the -XL weighs 3 pounds more.

Unlike the PC Plus, the Spirit is sold with a combined monochrome/color monitor board already installed. This board not only drives the builtin nine-inch green screen to emulate color with eight combinations of texture and brightness; it also can drive an external medium-resolution color monitor.

The basic specifications of the Spirit are the same as the PC Plus. The system is based on the Intel 8088 microprocessor, runs at 4.77 MHz, and includes 128K of RAM, an 84-key keyboard, two serial ports, and one parallel port. The MS-DOS and CP/M operating systems and Microsoft's *GW BASIC* programming language are included.

The Spirit keyboard, which latches to the front of the machine for storage or carrying, has the same layout as the PC Plus. The return key is large and conveniently placed, and the backspace and left-hand shift key are where most touch typists expect them to be. An added feature of the keyboard is a pair of little foldout feet at the bottom rear that can tilt the board to a steeper—and for many people more comfortable—angle. Similar feet are located at the front of the main unit to raise it to a better angle for viewing the screen; however, some may find the feet inadequate.

Frustrated new users may feel that best use for the Spirit's four thick slip-cased manuals would be to prop up the front of the machine. Formidable they appear and are, since they contain lots of reference material. The user's guide, while rife with misspellings and not always clearly written, carries adequate information for getting started. The beginning sections of the MS-DOS and CP/M-86 manuals are also adequate but intimidating. The BASIC manual, written by Microsoft, is not suitable for a beginner.

The Spirit's metal cabinet is off-white with grey trim, which are by now familiar colors for Eagle watchers. It is sturdy and appears rugged enough to withstand the rigors of carrying about. The optional padded carrying case is recommended for travel. Its wide shoulder strap makes it possible to tote the machine more conveniently with both hands free.

Like the PC Plus, its mother board can accept up to 640K of memory when 256K-bit chips are used. Only 256K is possible with 64K-bit chips. Of the four expansion slots provided on the mother board, one is occupied by the graphics board and another by the floppy disk controller. A third slot is taken by the hard disk controller in the Spirit XL—leaving two open slots in Spirit-2 and only one in the -XL. Gaining access to the expansion slots requires the removal of six screws to loosen the ma-

chine's cover. However, getting at the mother board to add memory is major operation. A beginner should leave that to the dealer.

Whether it is wise to travel with a hard disk-equipped portable has been open to question. Eagle provides a utility for parking the read/write heads of the -XL to keep them out of harm's way when turning off the power. One acquaintance spends his work week in various cities and commutes home each weekend by train or airplane. He has been lugging a Spirit-XL, and so far he hasn't reported any trouble with the hard disk.

In all, the Eagle Spirit is a well-made and well-thought-out transportable system. It runs IBM PC software with ease. Its only drawback is the low resolution of characters when emulating color on builtin screen. Higher resolution monochrome characters are available by flipping some dip switches on the mother board, deep inside the cabinet. Would that those switches were on the outside of the machine.

Eagle Computer, PC Spirit-2 \$2,995; PC Spirit-XL \$4,795; Carrying case \$80

EPSON HX-20

Revolutionary when it first appeared, the HX-20 is the two-year-old grandfather of such lap computers as the Radio Shack Model 100 and the NEC PC-8201. After its first burst of publicity, it has managed to sell reasonably well. Somehow, though, this machine has never really seemed to gain the popularity it deserved—certainly nothing like the excitement that attended the arrival of Tandy's computer-come-lately—and it is already beginning to seem dated when compared with its descendants. Yet it is still a creditable super-portable, and it does offer some features that make it well worth considering.

The brain of the HX-20 consists of two proprietary microprocessors, 6301 chips. These are a CMOS version of the 6801 processor—relatively little-known territory for most of the assembly language programmers who might otherwise be interested in writing for this machine. Only 16K of working memory comes with the basic HX-20, but another 16K can be added.

The HX-20 is still one of the smallest, lightest computers that manages to pack in a full-sized keyboard. It is 11.375 inches wide, by 8.5 deep, by 1.75 thick—roughly the size of a computer magazine and hardly thicker than the most popular of the monthlies. It weighs in at a scant 3 pounds 13 ounces. This includes the builtin nicad batteries, capable of running the machine for about two days

before needing a recharge from the external power supply that comes with the package.

Its typewriter-style keyboard has full-stroke keys with a slightly soft, springy feel; there is no click of the sort that provides tactile feedback on the IBM keyboard. The keyboard also sports two cursor-control keys, one each for horizontal and vertical motion, and several small, rectangular function keys above the alphanumeric keys. If you press the NUM key, some of the letter keys on the right are transformed into a hidden number pad. In all, the keyboard seems convenient and well thought-out.

The liquid-crystal display is one of the HX-20's weak points, even when compared with other lap computers that use an LCD read-out. The character set is formed by a 5 by 7 dot matrix in a block of 6 by 8 dots; this is relatively crude, but not unreadable. The display shows only four lines of 20 each—about as few as it can and still remain at all useful. Think of it as a single line on a normal terminal, and its inadequacy becomes obvious. The shiny gray backing of the display makes it a little harder to read than some, and there is no way to tilt the screen to avoid glare from the surrounding lights.

One reason for the diminutive screen is a dot-matrix printer in the computer's upper left corner. Printouts are only 24 characters wide, and they are produced at a rate of 17 characters per second. There may be some use for a slow dot-matrix printer that produces a tape the size of a grocery slip, but few of us are likely to discover it. Epson would have done far better to save this space for a larger screen.

In the opposite corner is a builtin microcassette recorder used for mass storage. Information transfer is relatively slow, about 300 characters per second. This discourages applications that make frequent use of mass storage, but it is adequate for saving a text file at the end of a writing session.

I/O is limited to a serial port and a connector for a bar code reader. At least one parallel port should have been included, and perhaps another serial port as well.

Relatively little software is available for the HX-20, though Epson has claimed from the first that more is in the works. With the machine you get a Microsoft-style BASIC and a ROM cartridge of the *SkiWriter* word processor, by SkiSoft, of Cambridge, Massachusetts. This is one of the better low-cost programs now available for the Commodore and Atari machines. Used with so small a display, any word processing program would be handicapped, and the results are less satisfying than they might be.

This is a useful, reliable notebook portable, but it

is far from ideal. By including a cassette drive for mass storage, Epson has managed to avoid the one serious defect of the Radio Shack Model 100—the need to carry a separate tape recorder. The small, rather hard-to-read display is a defect at least serious enough to make up for this benefit, however. The bar-code reader port makes this a good choice for store managers who need a convenient data entry device for inventories, but similar add-ons are available for the Tandy and NEC equivalents.

In all, it is difficult to recommend for or against buying the HX-20. Its mix of features seems neither significantly better nor greatly worse than those of lap-sized competitors. For those who have some pressing need for a super-portable computer, the choice between today's models will probably be made on the basis of special circumstances, personal taste, or even whim. Others may well find it better to wait until machines with the features of, say, the Grid Systems Compass or the Hewlett Packard HP-110 fall nearer to this price range.

Epson America, \$795

GRID COMPASS COMPUTER

Screeching around the curve at over 70 miles per hour, Magnum pulls the powerful Ferrari's steering wheel hard as he enters the straight, level highway ahead. He's got less than 60 seconds to catch the black sedan that holds the secret of the case. He jams his foot to the floorboard, the accelerator answering his demands with hundreds of horses of raw power. The sleek red sports car can outdistance its more mundane cousin from Detroit quite easily. . . .

Entering the conference room, the two executives find their traditional seats of power. The Vice President of Operations has his Compaq computer with him, filled with this month's production quotas and his staff's successes at meeting them. He quickly sets it up for battle. The V.P. of Marketing has his aide hook up the IBM PC's keyboard and monitor so he can display his monthly sales volume with his favorite graphics package. Finally, the President enters the room. All is quiet as he unzips the black leather case and pulls out a sleek, black magnesium GRiD Compass. He plugs the telephone jack into the rear panel, attaches the battery pack and flips on the power switch. At the push of a few buttons, he is switched into GRiD Central. . . .

What a red Ferrari is to television, the black GRiD Compass is becoming to the corporate board room. Two magnificent machines. Both very powerful, both very state-of-the-art . . . and both very expensive. If you are looking for the ultimate in new

technology, and don't have to worry about its effect on your bank balance, you can even buy one of each, and plug the GRiD into the cigarette lighter of the Ferrari for that quick calculation as you hit the straightaway.

Weighing in at just under 11 pounds, the GRiD Compass is 2 inches high and takes up an area of 15 inches by 12 inches on a desk. It is powered by 110 volts, 220 volts, or an optional DC battery pack that also allows the use of an auto cigarette lighter. Power consumption is 60 watts, but watch out—this little beauty can really put out the heat. At the factory in Mountain View, California, the burn-in procedure is accomplished by letting the machine run in its own heat while the testing machines check for irregularities. In order to avoid any heat dissipation problems, you must always use the built-in "foot," which raises the computer off the desk, allowing the air to circulate freely underneath its magnesium case. The benefit is that the foot holds the machine at a very good angle for typing, much as the adjustment levers on the IBM PC's keyboard.

The computing power of the GRiD Compass comes from the use of two microprocessors, the Intel 8086 and the Intel 8087. The most common microprocessor on the market today is the Intel 8088, which is found in the IBM PC and many other machines. The 8086 is the 8088's big brother, a true 16-bit processor, capable of higher speeds than its smaller sibling because of its additional data lines. The 8087 is really an 80-bit arithmetic coprocessor, designed to make any program that does a lot of number crunching run from four to ten times faster—assuming that the program was written to take advantage of the extended 8087 instruction set.

One of the differences between a run-of-the-mill portable computer and the GRiD Compass is its 80 × 24 electroluminescent flat-panel display. The amber display is capable of producing 320 × 240 pixel graphics with reasonable clarity. While many "portable" computers have similar display capabilities, those that do are not really very portable, and those that are really portable have only a small display area, most commonly about 40 columns by 8 lines. As in all things, however, a price must be paid. The power requirements of the screen are high, and the heat produced by the GRiD is mostly due to the screen. On the positive side, *Lotus 1-2-3* displays very nicely, something you could not hope for from a small-screened Radio Shack Model 100.

Although diskette drives are getting smaller, only now are they becoming truly portable. GRiD's solution to this problem was to use 384K of non-volatile bubble memory. This means that you can attach a

disk drive to your Compass system at the office, read *Lotus 1-2-3* and several data files into the bubble memory, and then turn off the power. When you arrive home, both the program and the data will still be there, ready to complete the task at hand.

If you have ever tried to figure out how to do your computing in several places on the same day, you will certainly appreciate the GRiD. An IBM PC, when packed for shipping, fills three cartons and is anything but portable. A GRiD Compass with at least equal power will fill only half of your briefcase. The logistical problems of a computerized sales presentation in a distant city are no longer troubling. The airline ticket counter clerk will not scowl as you try to get your briefcase, your overnight bag, and three cardboard cartons into his plane. Don't try to use the computer in the airliner's cabin, however. Most airline companies do not allow you to use a computer onboard because the radio-frequency emissions the computer generates can interfere with the plane's sensitive electronic navigation equipment—hardly what you'd like to have happen when you're in the air.

In addition to the bubble memory, GRiD includes either 256K or 512K of RAM in its computers. With the 512K machine, you have an amount of memory that was unthinkable only two or three years ago and that still rivals the best of the desktop machines today. A 512K Model 1109 has sufficient room for *Lotus 1-2-3* and for a very big spreadsheet model as well. The trick to using that much memory is where the data comes from in the first place. If you have 384K of bubble memory and the machine will hold 512K worth of data and programs, something does not seem right. But there are several ways around this problem: the GRiD Portable Diskette Drive, GRiD Disk Storage System, GRiD Server, and GRiD Central.

The GRiD Portable Diskette Drive is a 360K, 5¼-inch half-height diskette drive that can be connected easily to your computer. The GRiD Disk Storage System is a combination of a 360K half-height diskette drive and a 10-megabyte Winchester hard disk. The GRiD Server is a compact, 16-bit multi-processor computer for sharing disk storage and peripherals among up to 44 GRiD Compass computers. It supports up to eight 40 megabyte disk drives, a cartridge tape backup system and up to 15 printers and plotters.

GRiD Central is a group of IBM computers located at GRiD's headquarters in Mountain View. GRiD users may dial up virtually unlimited storage from anywhere in the country using standard telephone lines and an optional 1200/300 baud modem built into the computer. Once you have an account

with GRiD Systems and have been assigned a password, you can retrieve software and store or retrieve files from GRiD Central. You can even receive software updates from GRiD over the system whenever they add capabilities to their proprietary software packages.

The GRiD comes with a lithium battery-powered clock/calendar and a built-in speaker with software-selectable volume. Additional hardware available for use with the GRiD computer includes a GRiD dot-matrix printer capable of speeds up to 80 characters per second and graphics support and a telephone handset that connects to the back of the computer for that office-of-the-future look. Several data communications tools are also available, including a VT100 terminal emulator and an IBM 3101 emulator.

There are two ways to use the GRiD computer. First, the manufacturer provides a complete set of management tools that all use a common set of commands and are not only powerful but are also easy to learn. The products currently available are *GRiDPlan*, an electronic worksheet; *GRiDPlot*, a graphics package; *GRiDFile*, a data base management tool; the *GRiDWrite* text editor; and *GRiDPrint*, a document formatter. Additionally, the user can buy the *GRiDBasic*, PASCAL, Fortran 77, and PLM languages to develop new programs.

The other way to use the GRiD is with its optional MS DOS 2.00 operating system. This software is the current standard of the microcomputer industry and provides access to thousands of programs originally written for the IBM PC. However, the GRiD should not be considered PC compatible. Most programs that were written to work on the IBM need to be revised to run on the GRiD, due to hardware differences between the two machines. Don't despair, however, because many of the most popular packages are available for you, including *Lotus 1-2-3*, *Multiplan*, *Wordstar*, *R:Base 4000*, *dBase II*, and *TK!Solver*.

GRiD Systems has set up a support network that is one of the best around. Not only is new and updated software available over the GRiD Central network, but if the computer or a peripheral device breaks down, a new one will be delivered to your location by Federal Express within 24 hours. If you need telephone support, the people on hand at the technical center know about all of the devices and software that is supported by GRiD. No more finger-pointing between the computer manufacturer, the software vendors and the peripheral makers. When there is a problem, it will be resolved quickly.

No doubt about it, the GRiD computers are expensive, even after the recent price decreases due

to manufacturing efficiencies. But if you can afford it, you should definitely consider the additional advantages of this machine when you are in the market for a computer. If you can put a price on your productivity, you will probably find out that the extra dollars spent will have a very short payback period. You get the sizzle of the Ferrari of computers, but also get a way to rationalize the purchase to you wife, your boss and yourself.

GRiD Systems, Model 1100 (256K RAM, 384K bubble) \$5,995; Model 1101 (Model 1100 plus modem) \$6,795; Model 1109 (modem, 512K RAM, 384K bubble) \$7,995; Model 1107 Tempest (Model 1109 plus special shielding) call GRiD for price.

HEWLETT-PACKARD HP-75C

The HP-75C is one of the most powerful hand-held computers now available and a genuine pleasure to use. If the single-line, 32-character display and the 65 calculator-style keys don't bother you, its rugged construction and beautifully integrated software combine to make a highly functional and truly portable 26-ounce machine. A BASIC interpreter, appointment scheduler, battery-backed up clock/calendar, and a text editor are all built into the HP-75C.

The HP-75C uses a proprietary Hewlett-Packard microprocessor. It comes standard with 16K of rechargeable battery-powered CMOS RAM, expandable to 24K. CMOS chips are designed to minimize power requirements. There are three slots for plug-in ROM cartridges; Hewlett-Packard's optional spreadsheet program comes in one. A built-in magnetic card reader lets you store programs and data files on 1300-byte capacity magnetic strips. A socket for the Hewlett-Packard "interface loop" lets you connect HPIL peripherals, including a video display controller, thermal printer, digital cassette drive, RS-232 port, and Centronics parallel port.

Displayable characters include the full ASCII set plus graphics and some Greek and accented Roman letters. The keyboard can generate all possible 8-bit character codes. Every key has auto-repeat and can be programmed with a string of characters, letting you speed up typing of common words and commands.

Text files, data files, and BASIC programs can be stored in the in-memory file system. Files can be protected by password, unusual for a hand-held computer. Files can be transferred across the Hewlett-Packard interface loop and to or from magnetic cards.

The key to creating text files is the built-in text editor, invoked at any time by pressing the Edit key. Lines up to 96 characters long are scrolled through the 32-character display. The List command pauses after displaying each line. The arrow keys are used to move left or right within a line, up to the previous line, and down to the next. Both insert and type-over modes are supported. Single characters can be deleted. Lines of text are specified by line number ranges, and can be moved, deleted, renumbered, and listed to the display or the printer. This is much less convenient than the screen-oriented editors used with larger computers or word processing, but then few users are likely to undertake long writing projects on this computer's tiny keyboard.

The HP-75C contains a clock and calendar that is accessible at all times by pressing the Time key. In addition to giving the current time and date, it forms the basis for the appointment scheduler. The "Appt" key starts the appointment scheduler program, which lets you set up appointments by day, date or time. The program is smart and knows enough to fill in the day of the week if you supply the date, or the date of the next occurrence if you supply the day of the week. The content of an appointment is usually a brief message such as "MEET WITH JONES." When it falls due, any one of nine alarm sounds can be generated. Appointments can be automatically rescheduled if they recur.

A very powerful BASIC language is built into the HP-75C. Internal calculations are performed in decimal for accuracy. Exponents can range from $E-499$ to $E+499$, letting you represent both very small and very large numbers. Data types include 12- and 5-digit floating point decimal numbers, 5-digit decimal integers, and strings limited in length only by available memory. Numeric arrays of one and two dimensions are supported.

An unusually full complement of trigonometric functions is provided, operating in both degrees and radians; scientists and engineers will find this an asset. User-defined functions can span multiple lines, a feature that many a big-machine BASIC lacks. BASIC programs can include interval timers that range from less than a second to hundreds of years. When a timer goes off, a statement is executed.

Another very impressive feature of this BASIC is its integration with the rest of the machine's built-in software. The text editor is used to edit BASIC programs, and appointments coming due can trigger the execution of BASIC programs.

A well-written manual accompanies the HP-75C.

The first thing you will probably notice is that it is larger than the HP-75C itself! A more portable quick-reference guide is also included. The main manual includes a good tutorial with examples, followed by reference chapters on every part of the machine. A detailed index makes it easy to look things up.

The HP-75C is an unusual hand-held computer with many intriguing and fun-to-program features. It can form the nucleus of an extremely powerful and yet highly portable computing system. It will probably appeal to users from construction engineers to navigators on racing sailboats—anyone who requires super-portable computing power and can live without a large screen or typewriter-quality keyboard.

Hewlett-Packard, \$995

HEWLETT-PACKARD HP-110

Without question, the HP-110 is a technological tour de force. A true 16-bit notebook portable based on the Intel 8086 chip at a $5\frac{1}{2}$ MHz clock rate, it runs a bundled—burned into ROM—*Lotus 1-2-3* quickly and conveniently. A built-in 300-baud modem along with a comprehensive communications program, also ROMed, are top-drawer features. In fact, there are so many bells and whistles on the HP-110 that it would take the average new user months to explore and make use of all it can do.

Evidently expecting the HP-110 to be an archetype, Hewlett-Packard calls its nine-pound baby "The Portable." It is self-contained in a handsome off-white molded high-impact plastic case measuring 13 by 10 by 3 inches. The machine runs on rechargeable lead-acid batteries for 16 hours of continuous use starting on full charge. A hinged cover, containing a 16-line by 80-column liquid crystal display, protects the keyboard for transport and storage. It unlatches and flips up for use and can be set at any angle for comfortable viewing.

Unfortunately, however, the readability of display depends primarily on the angle and intensity of lighting. Attempts to use the HP-110 in the daylight in a taxicab, in bed with a reading lamp over the shoulder, and in a daylit room were frustrating. It was impossible to rid the front of the display of unwanted reflections. And despite use of the screen contrast control key on the keyboard, a usable contrast for strainless viewing could not be found. Trial and error resulted in discovery of optimal lighting conditions: an artificial lamp placed directly over the display, or above and slightly to the rear to reduce overhead glare.

It would be interesting to know the physical characteristics of a person able to comfortably use the keyboard and view the display while seated in a moving vehicle or even on a chair at home. The author is seated in the subway while writing this paragraph, and the HP-110 sits atop a canvas shoulder bag which raises the machine and the keyboard about five inches off the lap. The bag also provides sufficient friction to keep the machine from sliding. But what if the train makes a sudden stop?

The 75-station keyboard on the HP-110 is virtually identical to that of the HP-150. There are eight function keys above the number keys to address various functions according to the program being used. The feel and sound of the keyboard is lightweight and plastic but is not troublesome. The keys are of standard size and are not crowded. The layout is pretty close to that of the IBM Selectric typewriter, with no surprises other than a few dedicated keys to either side of the space bar. They do not get in the way. There is no numeric pad, and the cursor keys are on the top row at the far right, making them somewhat inconvenient.

Instead of a built-in disk drive, the HP-110 uses part of its 272K of RAM as a virtual disk (RAM disk). Users can partition memory between the system and RAM disk according to needs. This arrangement allows files and programs to be rapidly called up for use. In addition, the entire RAM is continuous. That is, programs and data are always saved because the HP-110 is never fully powered down. Only the display—which is the most power-demanding part of the machine—is shut down when it is turned off.

The software contained in ROM constitutes the HP-110's second virtual disk drive. Packaging software in ROM is expected to become prevalent in the industry. Judging from the performance of the ROMed *Lotus 1-2-3* in the HP-110 it's not a bad way of doing things. Every aspect of the program runs smoothly and quickly, including graphics. This is despite the display's size and the problems of making it comfortable to view; the graphics are displayed quickly and with good resolution.

It is not possible to rave about *MemoMaker*, HP's bundled word-processing program. Even the manual apologizes for its lack of power. Despite the succession of menus at the bottom of the display that prompt the user to execute the various word-processing functions, their use is inconvenient. Better to have bundled *WordStar*—which is available for the machine but was not tested—than to have stuck what is little more than a glorified line into such a sophisticated little machine.

A portable battery-powered 3½-inch microfloppy disk drive unit is an option for the HP-110. Designated the HP 9114A, the unit weighs 5 pounds and measures 8 by 11½ by 3 inches. The drive readily connects to the computer, and while it reads and writes somewhat slowly, its 710K storage capacity makes it attractive.

Truly a piece of high-tech jewelry, the HP-110 will certainly satisfy most users. Ease of interfacing with other Hewlett-Packard equipment should make it especially attractive to those already using HP products. However, the machine presents annoyances such as the display and the fact that it requires software packages customized to the peculiarities of the unit. Some may not find it a truly convenient computer for all seasons.

Hewlett-Packard, HP 110 computer \$2,995; HP 9114A disk drive \$795

HYPERION

The Bytec Hyperion is either far more than just an IBM clone or little less than one, depending on your point of view. If you insist on having a system that is 99.94 percent identical to the IBM PC, then be forewarned that the Hyperion isn't for you. Its keyboard layout is different, its physical design is different, and some programs that will run on the IBM will not run on the Hyperion. Nonetheless, if you want a system that is mostly compatible with the IBM PC and is clearly an improvement in many ways, then the Hyperion may be just what you're looking for.

Probably the most striking aspect of this system is its physical design. Bytec calls it a desktop portable and, indeed, that's just what it is. If you've ever had the dubious pleasure of walking four or five blocks while carrying forty pounds of "desktop portable" computer, you've probably decided that these misnamed devices are portable only if you happen to have a forklift truck handy. Not so with Hyperion.

To begin with, this computer weighs in at only 21 pounds with two disk drives or 18 pounds with a single drive. Portability is further encouraged by a built-in handle and a detached keyboard that slips securely into a hideaway slot at the bottom of the computer. For more extensive transport, the system fits into a carrying bag about the size of a gym bag. The entire unit (computer, disk drives, 7-inch screen, and detached keyboard) measures roughly 18 inches wide by 10½ inches deep by a sloping 6½ inches to 9 inches high. All of this makes the Hyperion a truly portable system.

"Fully loaded" is a good description for this system. Inside the box is an 8088 CPU, the same processor that's found in the IBM PC. The disk drives are also IBM-compatible. Their storage capacity is 320K per disk. In addition, the Hyperion has 256K of RAM, an RS-232 serial port (it uses a male DB-25 connector), a Centronics-compatible parallel port (this uses a female DB-25), video control electronics complete with a video output jack for use with an external monochrome monitor, a socket for an 8087 chip, and more. All of this comes with a one-year warranty.

If all these standard features on the Hyperion aren't enough for you, you can add the Hyperion EX, an expansion chassis with room for seven IBM-compatible cards. This expansion chassis is slightly larger than the Hyperion itself. The EX chassis can be had with or without a 10-megabyte or 20-megabyte hard disk, and it will let you expand the Hyperion's internal memory to as much as 640K RAM. A connector on the Hyperion is reserved specifically for the expansion chassis.

Unlike most IBM PC clones, which have chosen to copy the PC right down to its lamentable keyboard, the Hyperion sports a much improved, nearly Selectric-style layout that solves most of the problems with the PC keyboard. Among other things, the Caps Lock key and the Return key have been moved back to where Selectric-trained fingers expect to find them, and the arbitrary and confusing symbols from the PC keyboard have been replaced with words. Also, the ten function keys are lined up across the top in two groups of five each, rather than crammed into the left side of the keyboard.

The only important difference between this layout and a Selectric layout is that the Backspace key has been moved down one row to where you would normally find the upper extension of the Return key. The standard position for the Backspace key is occupied by two keys—one contains characters, the other is a Num lock key. A major potential drawback to this keyboard is that it feels a bit soft, but that's a matter of individual taste. Still, compared to the problems that Bytec has eliminated here, those problems that remain are trivial.

One final point about the keyboard is that it tends to slide around a bit. This is one of the few design oversights in this machine. One way to solve the problem is to fold over a piece of masking tape so that it is sticky on both sides, then tape it to the plastic legs that snap out to prop the keyboard up at an angle. Even after the tape has picked up some dirt, it remains tacky enough to hold the keyboard in place. Although this trick works, it is a less ele-

gant solution than this machine deserves. It would be nice if Bytec would add rubber tips to the legs.

The seven-inch amber screen on the Hyperion displays a full 80 characters by 24 lines. A twenty-fifth line at the bottom of the screen is reserved for function key prompts. The seven-inch screen is reasonably readable, and its readability is further enhanced by the recessed brightness and contrast controls that sit next to the screen. The character set is visually pleasing, but its letters are small. If that bothers you—and it might, if you have anything less than perfect vision—you can always connect an additional monitor with a larger screen.

Be aware that the video output from the Hyperion is monochrome only. Although the system has a setting labeled "color," and it will run programs that normally require a color board, it can generate only monochrome output. If you want color, you will need to get the expansion chassis and an IBM-compatible color board.

One problem with the screen is that the cursor blinks. If you feel that this is a problem, you can transform the blinker into a steady cursor. Bytec says that it will give the information on how to do this to anyone who asks.

If you haven't done anything at the Hyperion's keyboard for three minutes, the computer assumes that you're not interested in seeing anything and blanks the screen out. This saves energy and prolongs the life of the equipment. Touch any key, and the screen comes back to life. The recessed on/off switch has a ready light that tells you whether or not the machine is on. If you would rather not have the screen blank out, you can eliminate this feature permanently or temporarily with a simple command from the operating system.

In addition to everything described up to this point (except for the expansion chassis), the standard Hyperion package includes the MS-DOS operating system, *Microsoft BASIC*, and the *Aladdin Relational Database* program. The operating system for the Hyperion deserves more than passing mention. In addition to being more or less IBM-compatible, it includes an extremely useful, interactive version of the MODE utility. In standard MS-DOS, MODE is strictly command-based. In the Hyperion version, self-explanatory menus are available as well. Once you are familiar with MODE you can bypass the menus and use command lines instead, but until you reach that point the menus are more than a little helpful—especially if you are new to computers.

Among other things, the MODE utility will let you set the system so that the Hyperion will automatically come up with anywhere from 0K to 160K RAM

assigned as a disk emulator. The menu also lets you choose between monochrome mode, color mode, or "either." Usually you can leave the operating system set for "either" and let the program you're using make the mode choice for you, but some programs insist on seeing the system already set for one mode or the other before they will run.

This brings us to the question of program compatibility. As of February 1984, Bytec listed over 250 software packages written for the IBM PC that were known to run on the Hyperion. These include such well-established favorites as *dBASE II*, *Crosstalk XVI*, and *WordStar*. In addition, Bytec offers its own set of Hyperion-specific programs including Hyperion versions of *Multiplan* and *Lotus 1-2-3*.

A random sampling of about fifteen programs written for the IBM yielded a nearly even split between the number that worked on the Hyperion, and those that didn't. Bytec says that this is a much higher level of incompatibility than it would expect. However, IBM programs that are least likely to work on the Hyperion are communications programs and, by chance, most of the programs tested for this review were communications programs. According to Bytec, most of these programs will work on Hyperion if you use them with the expansion chassis and a communications card.

In addition to its versions of *Multiplan* and *Lotus 1-2-3*, Bytec offers three pieces of Hyperion-specific software: *IN:TOUCH*, *VT-100 Terminal Emulator*, and *IN:SCRIBE*. *IN:TOUCH* and *VT-100 Terminal Emulator* are both communications programs. The *Terminal Emulator* allows the Hyperion to emulate the popular DEC VT-100 terminal.

IN:TOUCH is part of a package that includes an optional internal 300-baud modem. The internal modem is a nice idea, but, considering the cost of the Hyperion, it is puzzling that Bytec settled on a 300-baud modem rather than a 1200-baud modem. *IN:TOUCH* is a standard smart terminal program. Its features include auto-dial, auto-log on, and the ability to transfer files directly to or from disk. The program does not include error-checking protocols.

IN:SCRIBE, the third Hyperion-specific program, is subtitled "Executive Word Processor." It is easy to learn how to use *IN:SCRIBE*, but its usefulness is limited. In reformatting paragraphs, for example, the only way *IN:SCRIBE* can recognize the end of a paragraph is if it is followed by a blank line. This is fine if you are writing a letter in block format but virtually useless for many other kinds of writing. Even at only \$155, this program is no bargain.

Two other points about the Hyperion speak very strongly in its favor. First, and most important, its

manuals are good. The User's Guide introduces you to the computer and to its operating system in clear English. Even if you're new to computers, you should have no trouble with this manual. Second, Bytec doesn't penalize you for buying the system piecemeal. For example, if you buy one disk drive and add the second drive later, it costs exactly the same as it would to buy the two-drive system all at once.

Bytec-Comterm, Basic system with 256K RAM and one disk drive \$3,195; with two disk drives \$3,690; one disk drive, purchased separately \$495; Soft carrying case \$65; Internal modem and terminal emulator program \$395; Acoustic cups for internal modem \$65; Hyperion EX basic unit \$895; EX with 10-megabyte hard disk and disk controller card \$2,600; 10-megabyte hard disk and disk controller card, purchased separately \$1,705; I/O card and cable for EX \$395; Expansion card for IBM PC \$195

IBM PORTABLE PERSONAL COMPUTER

After the introduction of the IBM Personal Computer in August of 1981, several microcomputer companies began to produce machines to compete with the PC. In order to compete, each had to find some way to attract the would-be PC buyer away from IBM. The most successful of these manufacturers were those who built portable computers that were compatible with the PC, such as Compaq, Corona, Columbia, Eagle, and Kaypro.

The best known computer in this category was the Compaq Portable Computer. For over a year, Compaq was able to keep its sales growing at an exceptional rate. Not only did its portability attract a significant number of buyers, but during this same period IBM was having trouble keeping up with the demand for its small computers. This left the door open for Compaq to pick up market share from the buyer who did not want to wait four to six weeks for an IBM.

Anyone who has tried to move the IBM Personal Computer from place to place would testify to its lack of portability. In the standard configuration, the PC comes in three different boxes, each more cumbersome than the one before it.

Taking all of these things into consideration, IBM designed a Portable Personal Computer and released it in February of 1984. The new system has been well received by the marketplace, and should help IBM to retain the title of top dog in the personal computer field.

Unlike its brothers and sisters in the PC line, the PPC doesn't take hours of study to configure a

working system. A ready-to-run basic system comes with 256K (262,144 characters) of Random Access Memory (RAM) already installed on the system board. It also comes with a keyboard, a double-sided floppy diskette drive, and a built-in amber display driven by the IBM Color/Graphics adapter. PC DOS 2.1 must be purchased to complete the basic system. This includes the latest version of DOS and both advanced versions of the BASIC language, Disk Basic and Advanced Basic. A second 360K floppy diskette drive can be added. Incidentally, the PPC uses the same half-height floppy disk drives as the PCjr.

Expanding the PPC can be a little traumatic because of a design limitation. In order to fit all of the necessary parts into the computer's cabinet, IBM had to restrict the use of the "long" expansion slots familiar to standard PC users. The PPC has seven usable slots, three long and four short. Unfortunately, two of the long slots are used by the basic machine for the display adapter and the diskette adapter. That leaves only one long slot available to expand the Personal Portable. Since most add-on vendors manufacture only the long boards, PPC users must carefully decide how to use the remaining slot. As more vendors add short boards, this problem will be alleviated, but that could take many months.

Competing for the long slot are the adapter boards that IBM left out of the basic configuration: a modem, a memory expansion card, a monochrome display/printer adapter, a fixed disk adapter, and a multifunction board. Two of the four short slots can be filled with IBM's Printer Adapter and Asynchronous Communications Adapter. Beyond these two cards, a search for short card vendors is in order. Several have recently emerged because of the 3 short slots in the PC XT. More will undoubtedly enter the market soon.

The Portable Personal weighs just over 30 pounds, a little more than the Compaq. It is portable, but not the easiest machine to carry around. Most dedicated carriers will find themselves switching hands to give their arm a break on the way from the parking lot to the airline counter. But compared to the original PC, it's a dream. The PPC comes complete with a canvas tote bag. The bag has both a carrying handle and a shoulder strap. The PPC's 20 inch by 17 inch by 8 inch size is not the smallest of the portables, but it gets the job done. IBM even included a small compartment in the front of the Portable PC that can be used to carry around those important files and programs in a semiprotected environment.

The keyboard on the PPC is similar in size and

design to the PC's keyboard, including all of the good features and, unfortunately, all of the bad features. It has 83 keys, each with audible and tactile feedback, nonglare surface and just the right amount of tension. It weighs in at around four pounds, a little lighter than the PC keyboard. The keyboard case is an integral part of the computer case, and can be folded down and used while still attached to the front of the computer. This is a nice feature for all of those places where there is no appropriate desk or table available on which to place the keyboard.

The keyboard attaches to the computer via a coiled cord, about 30 inches long, and a modular telephone plug. The cord's length is good, causing the user none of the "snap-back" problems seen in the Compaq. The placement of the cord causes one minor problem, however. It emerges from the top of the keyboard case and prevents the use of those popular plastic templates that are "cheat sheets" for many computer users. The templates are especially useful when the user is traveling and can't carry around an armful of heavy manuals.

The built-in monitor measures nine inches diagonally, and is IBM's first amber screen for the PC line. It is driven by the built-in Color/Graphics Adapter card, which can also be used to run a color monitor or a color TV set (if you buy an RF Modulator). The amber monitor can produce a set of 256 characters on a screen that is 80 columns wide by 25 lines deep. Because it is run by the Color/Graphics Adapter, it can produce graphics, but in only one color. And because the C/G adapter has a lower resolution than the PC's Monochrome Adapter, the quality of the text is not as good. If the higher quality text of the monochrome monitor is needed, the one remaining long expansion slot must be used to accommodate its adapter board.

The Portable PC has a power supply that can be used on American 120 volt power or on European 230 volt power, a boon to international travelers. This helpful feature, along with the amber monitor, is probably the result of IBM's desire to capture some of the European market with the Portable Personal Computer.

The PPC comes with one 360K half-height floppy disk drive and can be expanded to a second drive quite easily. IBM does not currently offer a fixed hard-disk drive for the PPC, but the machine has enough power in the power supply so the user can do this, if desired. Also, the PPC can be used with the IBM-PC Expansion Unit, allowing the addition of one or two 10 megabyte drives. As an added bonus, the Expansion Unit has eight expansion slots, making up for the lack of slots in the PPC.

DOS 2.1 is the only operating system which will run the Portable Personal Computer. Because of this, the disk drives can hold 360K each, rather than the 320K available from DOS 1.1. Programs written with DOS 2.1 can also be run on the PCjr, but due to hardware considerations, not all PPC programs will run on the PCjr.

The PPC is compatible with the PC in most respects, with two exceptions. First, programs written for use with DOS 1.1 only will not run because there were very basic changes between the two versions. Fortunately, there are very few programs that have not been converted to the DOS 2.xx series. Second, any program written to use the monochrome monitor exclusively will not run because the PPC uses the Color Adapter. To solve this problem, the user must purchase the Monochrome Adapter and monitor.

For the computer purchaser who wants a PC-compatible portable, the IBM PPC is as close as you can get. The trade-offs are minimal and the PPC will fit well in an environment where PC's are used by day and something is needed for those late night home projects.

The documentation provided by IBM for the Portable Personal Computer is complete and well-written. IBM quality shows through everywhere. An additional bonus is the set of IBM tutorials that take the user through the hardware and software step by step.

Service is available at thousands of authorized IBM service centers throughout the country. The machine comes with a three-month warranty and an optional service contract, if desired.

The IBM Personal Portable Computer should do well in the corporate environment, where people will always need a machine to take on the road or to use at home at night. It should also make a significant dent in the home computer market because it has a lot of power for a reasonable price. It may even help start the two-computer household, a feat that the IBM PCjr, due to a lack of acceptance by the home user, was not able to accomplish. IBM has shown that even if it does not beat the competition to the punch, it will keep its products competitive. This is always an important factor when choosing a vendor.

International Business Machines, IBM Portable PC, 256K \$2,795; Additional 360K disk drive \$425; PC DOS 2.1 \$65; Asynchronous Communications Adapter \$120; Printer Adapter \$150

KAYPRO SERIES

The KayPro computer family, consisting of the KayPro II, KayPro 4, KayPro 4-84, and KayPro 10, is

a very powerful line of computers, and they are probably the least expensive machines now available for the serious business user. These high-quality systems include more bundled software than most people will possibly need to run a business, learn computing, or upgrade an existing system.

They are arguably the best value in the micro-computer industry in the world today. The only extra required is a printer, and as there seems to be a printer price war going on right now, it is possible to get a top of the line KayPro with a letter-quality printer for around \$3,000. It is so cheap to do professional level computing these days!

All KayPro machines are about the size of a small suitcase, folding up into a compact and portable 8-inch by 16-inch by 18-inch package that weighs close to 30 pounds. They fit easily under the seat of an airplane, so KayPros are easy to take along if you are traveling. A word of warning. The case is heavy-gauge aluminum and it does have some sharpish corners. Be forewarned that it can snag.

All machines feature a 56-keyboard in the standard IBM Selectric layout, a full number pad with the dash, comma, and period as well as an Enter key and the necessary four cursor arrow keys. It is attached with a six-foot coil cord connection, allowing you to sit with the keyboard on your lap if you are inclined to do so. There is a definite click when a key is hit. It's quiet, almost not there, so unobtrusive that it will not distract you from your work, yet giving you the feedback we seem to need to be sure that we are in fact depressing the keys. The keyboard is set at a comfortable angle for working. The keys are nicely textured and cause little long-term fatigue during extensive work sessions. The "f" and "j" keys have a noticeably deeper indentation, making it easy to be sure that your hands are in position on the home row.

All KayPros have easy to read nine-inch green screen monitors. The phosphor is not so slow that characters drag and ghost when they scroll off the screen. This is a great improvement over the very early monitors, when the screen was so fast that it became covered with snow when the machine was doing disk operations or loading a program. The one remaining flaw is that it blinks slightly with each keystroke. A problem on early KayPros, this is now so unobtrusive that many users never notice it.

The family can be broken into two categories: The KayPro II and the KayPro 4 in one, and the KayPro 4-84 and KayPro 10 in the other.

The KayPro II and the KayPro 4 are basically the same machine, different only in the capacity of their dual 5¼-inch disk drives. The KayPro II has

single-sided disk drives with 191 kilobytes of storage each, while the KayPro 4 has double-sided drives with a capacity of 390 kilobytes each. The KayPro 4 will boot from KayPro II disks, allowing those who have KayPro IIs to upgrade their machines with no trouble at all.

The KayPro II/4 uses a Z-80 CPU running at 2 MHz, so it tends to be a little slower than some of the newer machines on the market. Even so, nothing now on the computer market can compare with the value of this machine, and for a few more dollars a 3½ MHz option can be added. KayPro is even now upgrading the II/4 combination to use a 4-MHz Z-80 chip.

The KayPro II/4 has one Centronics parallel port and one RS232-C serial port. This allows the user to add both a printer and a modem without difficulty.

The KayPro 4-84 and 10 are also identical with the exception of the disk drives. Both the KayPro 4-84 and KayPro 10 feature a 4 MHz Z-80, making the machine a fair bit faster than the current II/4s being marketed. The 4-84 has two double-sided drives with a capacity of 390 kilobytes; the KayPro 10 has one floppy-disk drive with 390 kilobytes storage and a 10 megabyte hard disk on board.

The hard disk is fast and is very impressive. It was not so long ago that a hard disk had to be mounted once and never moved. Modern high technology has set this problem aside and given us tremendous computing power wherever we go. The drive holds up well while traveling, perhaps because when the machine is turned off a utility program is used to "park" the read/write heads away from the disk surface. When the KayPro was first released there were problems with the hard disk, but KayPro was very quick to correct this problem and the machines are now quite sound.

Both the KayPro 4-84 and the KayPro 10 have one Centronics type port and two RS-232C ports. One is marked "COMMUNICATIONS," and the other is marked "SERIAL PRINTER." This saves time if you are using two different printers—perhaps a fast dot-matrix unit and a letter-quality model—and you do a lot of networking.

The KayPro 4-84 and the KayPro 10 are not able to read KayPro II disks directly, but a utility program is included that enables them to read KayPro II disks.

The existence of these utilities and the portability of these machines ensure that the user doesn't have to worry about cross-loading information before going or returning from a business trip. These machines are so well behaved that one hacker who laboriously put together a large S-100 system with a lot of off-line disk storage discovered that since

he bought a KayPro 10, he has virtually stopped using his S-100 system.

KayPro reportedly plans to add an optional built-in modem on the KayPro 10. This option will make the KayPro computer even more valuable to someone who is looking towards networking in the future. If this is true, and I hope that it is, that option should also be available on the 4-84. I remember the joy of first connecting the modem for the Osborne, using the auto-dial and raising any bulletin board system without difficulty.

The software package includes *Wordstar*, the most common of the CP/M based word processors; *dBase II*, the most powerful database management package in the current marketplace for micro-computers; *SuperCalc*, one of the better spreadsheet programs on the market; and *SBASIC*, a non-standard BASIC modeled after Pascal. Microsoft's *MBASIC* is included as well.

There are a number of useful utility programs included with the software package. The most important of these is *Uniform*. This little dandy gives the user the ability to read, write, and format between 12 and 28 different 5¼-inch formats, depending on the version. This gives the KayPro user tremendous power and flexibility in moving text or programs between machines.

KayPro machines operate under CP/M 2.2, by far the most common operating system in the micro-computer world. In addition to the standard CP/M utilities, KayPro has included their own *Copy*, *Formatting*, *Configuration*, *Baud*, and *Terminal* utilities, which are optimized for the machines.

The *Copy* program allows copying/verifying of a disk. Other options under *Copy* are fast copy, which does not verify, and verify only, which confirms that the disk in drive B is identical to the disk in drive A.

The *Format* utility allows single-track formatting, which is particularly useful in removing system tracks.

Config is a configuration program that allows the user to set the default I/O byte for the logical and physical devices. This can also be done using the CP/M utility *Stat*, but *Stat* will only set the defaults while the machine is running. This program sets it and then patches the BIOS of the machine so that the chosen defaults will be there every time the computer is cold booted. *Config* allows reassignment of the four cursor keys to fit a particular program. Another important feature allows the reassignment of the keypad definitions so that the numeric keypad can be changed into 14 function keys using the standard ASCII codes. This allows people who are used to the DEC keypad functions to put their own on the KayPro. This can be the

difference between easy operation and frustration in use of the KayPro.

Baud allows you to set the baud rate for communications through the serial port for either serial printers or modem communications when you need it set for just the current operation. It gives you a choice of the eight most common baud rates to choose from, and it is a simple keystroke to change the rate.

Term will turn the KayPro into a dumb terminal if you wish to connect to a larger computer. The KayPro is a very expensive terminal, but this utility can be handy if you have another system and its terminal goes down.

For the price of the computer you get not only the machine but word processing, database management, spreadsheet calculations, and a programming language.

Do you want to set up bookkeeping for your home/business? *dBASE II* comes with a very sophisticated bookkeeping package, so that as you're learning *dBASE*, you can start doing bookkeeping.

Do you want to do some projections on your income? *SuperCalc* will do it for you.

And so it goes.

All of these programs come with documentation, which is primarily KayPro's reprinting of the manuals from the original manufacturer. This is not always the best, but it does assure that the end user will have no more problems with the documentation than his friends and associates. A major failing of most software publishers is that they assume the user is already familiar with computers. As a result, there is less redundancy than is needed now that personal computers are nearly universal.

To enhance the KayPro computers in this very competitive market, there are a plethora of add-ons. These are not manufactured by KayPro, but some of them do have the firm's blessing. Among them are the desk-top stands for mounting the machine in an office, a disk-drive controller to expand the B drive to use a 96-TPI double-sided disk drive, and another controller to add an eight-inch drive as drive C. The list continues with more and more add-ons coming on the market daily. These items can be found advertised in almost all of the micro-computer-oriented publications.

KayPro itself has recently provided one add-on that many users will want—an 8088 coprocessor board that makes these CP/M portables compatible with the IBM PC. Produced by SWP Microcomputer Products of Arlington, TX, the Co-Power 88 board can be purchased with the computer or added later. Installing it is a simple job—about half an

hour's work requiring only two solder connections.

The 16-bit addition is well worth having. Nearly all MS-DOS programs will work with it, and the board also gives you access to CP/M-86 software. It will not run software that depends on machine features specific to the IBM PC, however; this rules out most MS-DOS graphics programs and also the majority of communications programs for the IBM.

Even those not interested in compatibility with the IBM—there must be a few—are likely to find the board's other use well worth having: The Co-Power 88 also works as a disk emulator. By substituting its 256K of RAM for the KayPro's relatively slow drives, you can speed up disk-intensive programs by a factor of 10 or more. If you use *dBASE* or an accounting package, the time saved will quickly repay the cost of the board.

Finally, there are uses to which the sturdy KayPro can be put that the manufacturers obviously didn't think of. Imagine a scene at a crowded airport. The busy KayPro owner, machine in hand, cannot find a place to sit. He places his computer on the floor and sits on it, a welcome relief from having to stand around waiting for a flight. It's a bit expensive for a portable chair, but what the heck.

Kaypro Corporation, KayPro II \$1,295; KayPro IV \$1,995; KayPro 4-84 \$2,495; KayPro 10 \$2,795

NEC PC-8201A

Beyond any useful function they might serve, lap computers have a certain gadget appeal. The PC-8201A is no exception. Weighing in at 3.8 pounds and measuring 11½ inches wide by 8¼ inches deep by a sloping 1¾ inches to 2 inches high, this complete system is roughly double the size and weight of a typical issue of *Byte* or *PC Magazine*. Put this battery-operated computer in your briefcase or tuck it under your arm, and you're all set to do your computing on the go.

Like other truly portable computers, the 8201A is based on CMOS technology and the lower power requirements of CMOS. According to NEC, a single set of four standard AA batteries will last for about one hour. A set of alkali batteries will last for over 18 hours. NEC also sells a rechargeable NiCAD battery-pack that will keep the computer running for about 5½ hours.

Also installed in the computer is a set of backup NiCAD batteries. A prominently placed "low-battery" light comes on to warn you when the main batteries are dead. At that point the backup batteries take over. These will keep the computer running for about 20 minutes, which gives you plenty

of time to notice the warning light and change the batteries. Alternatively, you can turn the computer off, and the backups will maintain the computer's memory for 26 to 30 days, depending on how much memory is in the system. The backup batteries have a life span of about 2½ years and can only be replaced by an NEC dealer.

The basic computer in the 8201A is an 80C85 CPU, with 32K ROM and 16K RAM. The 80C85 is a 2.5 MHz, CMOS version of the 8085. The 32K ROM contains the 8201A's version of BASIC, along with a text editor and communications program. (More on these later.) It also contains what passes for the 8201's operating system. The 16K RAM actually gives you about 12K to work with. The other 4K is reserved for workspace for the on-board programs.

The RAM can be added to in 8K increments to give you as much as 64K of internal memory. An additional 32K RAM can be added in the form of a cartridge that plugs into a slot on the side of the machine. This means you can have as much as 96K RAM available in the machine at any given time.

The RAM in the 8201A serves double duty. Not only does it give you a working area for whatever you're doing, but thanks to the battery backup, it gives you a place to store files as well. Whenever you turn on the machine or exit a program, you are presented with a list of files stored in RAM. To open a file or run a program, you simply move the cursor to the file you want and hit Return. New files are created automatically by the system where appropriate or are easily saved to RAM by a simple SAVE command.

One odd glitch in the 8201A is that chunks of memory occasionally go on vacation. Usually information held in memory is assigned to a file, and the memory can be freed up easily enough by killing the file. Under certain conditions, however, the *Microsoft BASIC* decides that a section of memory should be reserved for workspace and will not let you get at that section.

When that happens, 3K or 4K bytes of memory simply disappear. Since these missing sections aren't assigned file names, the only easy way to free up the memory for use is by going into BASIC and giving the system an appropriate command. This glitch is not documented in the 8201A manual, but NEC is aware of the problem and can provide the solution on request.

The screen on the 8201A has room for only 24 file names, three of which are already taken up by the three on-board programs in the system's ROM. The memory is set up in banks of 32K each, so you can switch from one bank to another and have up to 21 files in each bank. NEC supplies a program on cas-

sette tape that will let you transfer files from one bank to another.

When you run out of memory in any bank, the system does a heroic job of stopping you from accidentally overwriting the files you already have in memory. If you are in BASIC, you get an "out-of-memory" error. If you are using the text editor, you get a beep and a "MEMORY FULL" message. If you try loading files from tape or downloading files by way of the communications program, the system simply won't let you.

The RAM cartridge, incidentally, contains its own battery backup, which means you can remove it from the machine and replace it with yet another 32K bank of RAM. At \$395 per cartridge, though, there is a limit to how many RAM cartridges you'll want to invest in.

The stripped-down package, with 16K RAM, is both well conceived and well executed. The screen is a 40-column by 88-line liquid-crystal display. The large letters, combined with the adjustable contrast control make it eminently readable from just about any angle in any reasonable light. The one exception to this is if you are outdoors wearing polarized sunglasses. LCD displays are difficult to read through polarized lenses.

The standard-size keyboard uses a nearly Selectric-style placement for its keys. The one major complaint from touch typists is that the quote symbol and apostrophe symbol are capital numbers on this keyboard. Five Function keys in a row across the top are used along with the Shift key to give you effectively ten Function keys on the machine. You will also find four Arrow keys on the upper right side of the keyboard, arranged in an intuitively obvious four-points-of-the-compass design.

The built-in BASIC goes by the name *N82-Basic*. Written by MicroSoft, it is a subset of *MBasic*. Text is a low-powered, but easy to learn and easy to use, text editor. Most of its commands are concerned with cursor control, but it also includes a find feature, and the ability to delete or move text. *Telcom*, the Communications program, is difficult to learn and use, thanks to its somewhat obscure commands. You're likely to have trouble understanding *Telcom* unless you are already familiar with communications in general.

The 8201A also has several features that let you turn this system into much more than a lap computer. Built-in ports include a Centronics-compatible printer port, an RS-232 port, a cassette-recorder port, a bar-code reader port, and two "S10" ports. One of these S10 ports is meant for use with NEC's microfloppy disk drive. The other port is for "future expansion." Also reserved for

future expansion is the capability for an additional 32K ROM with more on-board programs.

The system also includes instruction manuals, a cassette containing about 20 simple programs in BASIC, a cable for connecting to a cassette recorder, and a soft vinyl case.

The microfloppy dual disk drive, with 160K of storage per disk, is not available as of this writing, but should be by the time this catalog is published. The battery-powered drive also includes 64K of additional RAM. This drive combined with a series of already announced business-oriented applications programs will rapidly increase the usefulness of the 8201A.

Combine the 8201A, the disk drive, and the upcoming CRT adaptor, and you can use this system as a full-fledged desktop computer with either a 40-column by 20-line screen, or an 80-column by 24-line screen. Even if you set the 8201A up as a desktop system, though, you can still unplug the main unit and throw it in your briefcase at any time. If you need this kind of portability, the 8201A should certainly be high on your list of possibilities.

NEC Home Electronics, PC-8201A \$799; NiCAD battery pack \$17.98; 8K RAM chips \$120 each; 32K RAM cartridge \$395; AC adaptor \$15.95; Battery-operated, 1.5-ounce, 300-baud modem \$79.95; disk drives and CRT adaptor available late 1984

ROADRUNNER

Weighing in at five pounds and just a bit too big to qualify as a lap computer, the RoadRunner from MicroOffice Systems Technology is one more entry in the world of truly portable systems. In most ways, it's one of the more promising contenders.

The basic design of the RoadRunner is more than a little attractive. A compact 11 $\frac{3}{4}$ -inches wide by 7 $\frac{3}{4}$ -inches deep by 2 $\frac{1}{4}$ -inches to 3 inches high, the system can fit neatly into one half of a briefcase, leaving the other half free for papers and such. Like other battery-operated, CMOS-based briefcase portables, the RoadRunner is a self-contained system with keyboard, screen, and computer all in a single package. Unlike most other briefcase portables, the RoadRunner's screen is contained in a cover that closes over the keyboard to protect both keyboard and screen in transportation.

The screen uses a liquid-crystal display of 80 columns by 8 lines. This compares favorably to the 40-column-by-8-line display that is typical of systems of this size and weight. Even nicer is that MicroOffice made the decision to put the screen in the

cover so it could be replaced with larger screens as new technology becomes available.

The pre-production model of the RoadRunner sent for review had some problems with readability, but these have apparently been solved in the production models.

An inherent problem with LCD displays is that their readability is highly dependent on your angle of view. From one angle, a given display will be eminently readable, while from another angle any information on the screen will be nearly invisible. There are two ways to deal with this. One is to adjust your angle of view. The other is to adjust the display. The typical lap computer opts for the second choice and adds a contrast control for the screen.

The pre-production model of the RoadRunner opts for the first choice. The design assumption seems to be that because the screen is in the cover, you can adjust it for whatever angle you need. In theory it's a nice idea, but in practice it doesn't work.

It doesn't work for two reasons. First, the hinges on the cover aren't stiff enough to hold the screen open at all angles. Once it gets past a certain point, the weight of the cover opens it all the way. MicroOffice says that a ratchet arrangement in the production models will hold the cover at your desired angle.

The second problem is more fundamental. The LCD display in the RoadRunner is protected by a piece of plastic. Depending on where you're sitting in relation to windows or ceiling lights, the plastic will produce reflections and glare. What a system like this ideally needs is an adjustable cover to get rid of the glare, plus a contrast adjustment for the display itself to adjust for the angle of view. MicroOffice says that this is precisely what they have added in the production model of the system. This should eliminate any readability problems of the screen, and will go a long way toward making this machine live up to its potential.

The keyboard on the RoadRunner uses a full-size, nearly standard Selectric layout. The shift keys, return key, and so on are all in their standard positions. The only important change is that the question mark/slash key has been moved and replaced by an arrow up key. The rest of the arrow keys are just below, taking up some of the space usually occupied by the space bar. The somewhat shortened space bar presents no problems. You probably never use the part that's missing.

A row of keys across the top of the keyboard includes a help key, a menu key, and eight function keys. The one unfortunate placement here is the

exit key. This takes you one step back from wherever you happen to be—from an application program to the operating systems, for example. The problem is that it's very easy to overshoot the backspace key and hit the exit key instead. If you make a typing mistake and mean to correct it by hitting the backspace key, you may find yourself unintentionally leaving a program. This can be a real disaster. If you are in BASIC, for example, writing a program, you will lose anything you haven't saved to a file.

The keyboard, incidentally, has a mushy feel to it, and the keys are a bit more wobbly than you might want. Still, it doesn't take long to get used to the keyboard, and it is perfectly adequate for full-speed touch typing.

The operating system in the RoadRunner is menu based. The computer turns on when you open the cover, and it wakes up showing you its Main Menu. If you need to perform any housekeeping chores, you pick the function key labeled "Utility." This takes you to the Utility Menu, where you can choose among various functions, including Directory, Delete a file, and Rename a file. The computer also comes with three built-in programs: a simple name and address database program, a scheduling program, and a communications program.

Above the keyboard are slots for four cartridges, designated A, B, C, and D. The slots effectively function as disk drives, and the cartridges as disks. Asking for the directory for "unit" A, for example, will give you a list of files on the cartridge currently in slot A.

Programs are available on cartridge in Read Only Memory. If there are program cartridges in the machine when you go to the main menu, the programs will show up as choices on the menu.

The RoadRunner is built around the NSC-800 CPU, a CMOS version of the Z80. According to the manual, the operating system is compatible with standard CP/M, and will run most generic CP/M programs. Relatively few program are available on program cartridges, but software can be downloaded to the machine through the terminal program. This lets you transfer files using the same error-checking protocol that you'll find in ASCOM, one of the better communications programs available.

The basic RoadRunner comes with 48K RAM plus 16K ROM, which makes it functionally equivalent to having 64K RAM with 16K taken up by the operating system. Also standard is a rechargeable (and removable) 8-hour NiCAD battery pack, and an RS-232 module that can be replaced by an op-

tional direct connect, 300 baud, 103-compatible modem. Acoustic cups are also available for the modem. Bundled software includes a "personal scheduler," an address and phone number directory, a VT 100 terminal emulator, and the MicroOffice word processing program. Other currently available program cartridges include standard *MicroSoft BASIC* and *Sorcim SuperCalc*.

The data cartridges for the RoadRunner come in various capacities from 8K to 64K. These use power saving CMOS technology and include a lithium battery to retain memory when the power is turned off. According to MicroOffice, the batteries are good for about five years, after which they can be replaced.

Overall, the RoadRunner is a useful, and even exciting, system. If you need the portability, and particularly if you already have a desktop system running CP/M, the RoadRunner is definitely worth looking at.

MicroOffice Systems Technology, Inc., RoadRunner \$1,775; additional battery pack \$35; 300-baud modem \$240; letter-quality printer \$695; RAM data cartridges—8K \$50, 16K \$95, 32K \$190, 64K \$350; *Microsoft BASIC* \$200; *SuperCalc* \$275; technical reference manual \$30

SHARP PC-5000

You might think that anyone who set out to design a portable computer would remember to put a handle on it. You would be wrong, of course. Consider the PC-5000 from Sharp. This unit is designed to be a fully integrated, self-contained system. It comes with a keyboard, screen, bubble memory "disk drives," and optional printer, all contained in a single unit. It also comes with word-processing and communications software as standard, (*SuperWriter* and *SuperComm*), plus an optional package that contains most of the programs you are likely to need. And, not-so-incidentally, the entire unit weighs roughly 12½ pounds.

The actual computer is an 8088 microprocessor with 128K RAM, expandable to 256K. The system comes with the MS-DOS operating system, and built-in BASIC in read-only memory. It includes a clock and sound generator, and has appropriate connectors for use with the optional disk drives, the optional modem, and an audio cassette player. A fourth connector is an RS-232 port for use with an external printer or any standard RS-232 modem.

Clearly, the concept behind the PC-5000 is more than a little attractive. Unfortunately, the execution of that concept leaves much to be desired. Don't

misunderstand. The PC-5000 is not a bad machine by any means. Far from it. But it's not as good as it should be. The package is filled with minor oversights and design flaws that succeed in turning a potentially exciting machine into a merely adequate one.

There is the matter of the missing handle, for instance. This system resembles nothing so much as a portable electronic typewriter—except that no one would be silly enough to design a portable typewriter without a handle. You might argue that this is only a minor oversight, and you might be right—especially considering that Sharp offers a choice of two optional carrying cases. But if you don't think it creates a problem, try tucking the unit under your arm and walking with it for five or six blocks. The experience will change your mind.

The keyboard is another good example of how just to miss getting it right. It has a nice feel to it, but it's a good bet that whoever designed it either does not touch type or else has extremely long and narrow fingers. This is another of those horrors where it is virtually impossible to reach the Backspace or Return key without taking your fingers off the Home keys. If you're a touch typist, and particularly if you still miss the feel of your Selectric, this is guaranteed to be annoying. The Caps-Lock key is on the right side (which is to say, the wrong side), where you can forget about using it for high-speed touch typing.

The top row of the keyboard includes the Arrow keys and eight Function keys. This is not the most convenient spot for the Arrow keys, but it does help to minimize the size of the keyboard. The software that comes with the machine makes maximum use of the function keys, and the bottom row of the screen displays the commands available on them at any moment. Unfortunately, the screen labels do not line up over the appropriate keys; the command for F5 winds up over the key F8, the command for F8 winds up over an Arrow key.

The screen on the PC-5000 also has problems. This liquid-crystal display of 8 lines by 80 columns is contained in a cover that closes over the keyboard. When you open the cover, it exposes both the keyboard and the display. The screen can then lock into any of several positions for visual comfort. Unfortunately, it is nearly impossible to eliminate glare and still have enough light on the screen to be able to read it. And when you close the screen, the wire that drives it becomes tangled in the hinge, which has a good chance of breaking it. Overall, the screen is tolerable, but no more than that. This is an acceptable price to pay for portability if you use the machine on an occasional basis,

but you won't want to deal with it day after day. Unfortunately, there is no way to connect an external monitor to this machine.

The optional 37 character-per-second thermal printer serves double duty. You can use it with heat-sensitive paper without a ribbon cassette or on so-called thermotransfer paper with a ribbon cassette. You can also use the thermotransfer ribbon with other paper, but to quote the manual, "If you do not use the recommended paper, your output may be of poor quality." The output on thermal paper is impressively good, and the print quality with the thermotransfer ribbon and paper is acceptable. Other papers give print that ranges from poor to nearly unreadable. If you need good quality printing on standard paper, you can attach an external printer through the system's RS-232 port.

The printer is another place where Sharp has almost done it right. When installed, this option represents about one quarter of the weight of the machine. There are times when this is a small price to pay for having a printer in a portable machine, but there are also times when it is simply dead weight. The system would have been much more attractive if the printer could be slipped in and out of the unit quickly and easily. As it stands, though, attaching it and detaching it is anything but quick and easy. It is meant to be installed once, then left in the machine permanently.

External storage for the PC-5000 is one of the places where Sharp did get it right. The bubble-memory cartridges for the machine are slightly smaller than a standard tape cassette, and only slightly heavier. These function in exactly the same way as disk drives and are treated as drives by the machine. At \$269 per 128K cartridge, you won't want to archive your files this way, but when you're carting the machine around, you will probably want to keep your current working files on the bubble disks.

For more permanent storage, you can attach a cassette tape recorder or the optional disk drives. In either case, installation is as simple as plugging in a cable. The drives can store up to 360K per disk, or they can be formatted to hold 320K and be interchangeable with data disks from the IBM Personal Computers.

The optional software for the PC-5000 adds *SuperCalc* (spreadsheets) and *SuperPlanner* (appointment calendar, phone book, index-card retrieval system) to the basic package of *SuperWriter* and *SuperComm*. These programs, all from Sorcim, form a more-or-less integrated package thanks to *SuperTools*, a kind of umbrella menu program that comes in the basic PC-5000 package and

allows the user to call up the other programs without dealing with the operating system.

If you're looking for a portable system, particularly one that will let you exchange data files with an IBM PC, the PC-5000 certainly belongs in the running. It's not the machine it might have been, but its limitations and design oversights can be lived with.

Only it would be nice if Sharp would add a handle.

Sharp, \$1995 with 128K RAM, MS-DOS, GW-BASIC, and cartridge; 64K RAM expansion modules \$169; 128K blank bubble cartridge \$269 each; printer \$399; 5¼-inch double-sided, double-density disk drives \$999

TELERAM

Notebook-sized portable computers with liquid crystal displays generally fall into two categories: the less expensive machines, which are little more than note takers or communications devices, and the higher-priced units, with power approaching that of desktop computers. The Teleram portable is among the latter group.

The basic models are the Teleram 3000, with a 4-line screen, and the Teleram 5000, with a 16-line screen. Both screens are 80 columns wide. Essentially a CP/M computer with 64K of RAM memory, the major difference between the Teleram and other CP/M machines is the Teleram's use of a magnetic bubble memory device rather than diskette memory for reading, writing, and storing data or programs.

Originally developed by Bell Telephone Laboratories, magnetic bubble memory stores digital data as north- or south-polarized magnetic domains, described as bubbles, within a crystalline magnetic material. The memory contents are nonvolatile; that is, stored data is permanently readable until magnetically erased or written to—unlike the RAM memories used in the TR-100 and the HP 110 in which stored data memory programs and data must be maintained by constant battery power. And unlike disk or tape memories, bubble memories have no moving parts; the bubbles are made to flow through the device to a location where they are read or written. The main disadvantages of bubble memories have been cost, capacity, and speed of data transfer—which is slower than both RAM and disk storage. However, bubble memory outperforms disks in terms of access time—the time spent looking for data to read or an area on which to write it. Bubble memory size greater than 256K was not available on the market until the re-

cently released 512 KB device. Another recent development has been a sharp price cut. However, expectation of a removable cartridge memory that could economically replace floppy or hard disks seems remote.

One of the principal if limited applications of magnetic bubble memories has been to store and automatically replay digitally encoded routine telephone voice messages such as, "We're sorry, the number you are calling is not in service at this time. . . ." The magnetic bubble playback machines have more than paid for themselves through maintenance costs far less than those of mechanical playbacks.

Teleram Communications was one of the first manufacturers of portable computers, principally the Portabubble, a bulky but lightweight single-purpose machine with a magnetic bubble memory and a CRT display. It is used by reporters and correspondents for creating and sending news copy by modem from remote locations to a newspaper's editorial and typesetting computer.

Wedge-shaped with a sloping keyboard, the Teleram 3000/5000 is 13 x 9 inches wide and deep by 3½ inches at the thickest end of the wedge. It weighs about 10 pounds, including a built-in lead-gel-cell battery pack that is not user-serviceable and which operates some five hours between rechargings. A bulky, heavy power supply/recharger, switchable for American and European voltages, is included.

The 83-station keyboard is compact and only appears crowded; the keys are of regulation size, although the return key could be just a bit larger. An uppermost row of 16 function keys can be programmed with up to 32 characters—for example to execute commands, call up programs, or enter commonly used character strings—in both the shifted and unshifted levels. Similarly, 12 unshifted and 7 unshifted eypad keys may also be programmed, making a total of 50 programmable keys—many more than most users would ever need! Since computer keyboards do not lend themselves to mechanical adjustments to suit a typist's touch, Teleram has come up with an electronic means to deal with this via a unique utility program. It allows the user to adjust both the rate at which characters are repeated when a key is held down and the delay time before the key starts to repeat.

Use of an 8-bit Z80L (low-power) microprocessor along with the CP/M operating system gives the Teleram access to several thousand application programs. Those full-screen applications that require a terminal configuration almost always contain a special utility for matching the program to

the Teleram's terminal emulation, which is the Televideo TV1920. Neither the 4- nor the 16-line Teleram display encompasses the entire 24 lines of the usual screenful of information. What is displayed is actually a 4- or 16-line window within the 24-line screen. The window can be moved up or down by pressing the shift key and one of several dedicated scrolling keys on the keypad. This takes some getting used to but is not overly inconvenient, especially in the 16-line Teleram 5000. The display screen is located above the keyboard and adjusts to several viewing angles. A contrast control wheel is combined with the on-off switch—which can be accidentally turned off while adjusting contrast. Both the 4- and 16-line screens were more readily adjustable and readable than most LCD displays.

A single RS232C serial communications port accessed through a female DB-25 female connector is located at the left rear of the machine. A bundled communications program called *teleTALK* is actually a customized version of *Crosstalk*. It provides modem (autodial and auto answer support) as well as machine-to-machine communications, and enables ordinary data as well as programs to be sent to or from the magnetic bubble "disk."

Taken altogether, the Teleram 3000/5000 is a well-designed and executed system, a suitable if somewhat expensive accessory to any desktop computer, especially those running CP/M. Not evaluated were Teleram's optional disk drives nor its desktop unit with CRT display and disk drives—which can be connected via a bus interface at the rear of the portable unit.

Note also that Teleram has focussed its marketing away from the highly competitive business and home computer markets, preferring to narrow its efforts toward newspapers and other specialized users. For this reason, Teleram's dealer network is limited.

Teleram Communications Corporation, Teleram 3000, 128K magnetic bubble \$1,795; 256K \$2,295; Teleram 5000, 128K magnetic bubble \$2,495; 256K \$2,995

TELEVIDEO TPC-I

TeleVideo started out some years ago as a maker of terminals. Their products never broke new ground technologically, but they were several hundred dollars cheaper than equivalent models from other manufacturers, and they were reliable once the firm got the bugs out of its quality control system.

TeleVideo's computers have followed the same

pattern: middle-of-the-road technology at a more-than-fair price. The TPC-I is their first portable. Predictably, it is an 8-bit machine with a 4-MHz Z80 processor running under the CP/M-80 operating system. It offers 64K of user memory—though it can be expanded to 128K—and comes with one or two double-sided, double density 5¼-inch disk drives with a formatted capacity of 340K. But for an 8-bit portable there are two novelties: 32K of graphics memory and provision for use with TeleVideo's local area network system.

The machine looks like many other transportable computers: a plastic box 17 inches by 15 by 8, with a fold-down handle at one end. It weighs about 30 pounds. A cover on one side opens to reveal a 9-inch screen and the vertically mounted thin-line disk drives. The keyboard is on the inside of the cover. Another small cover on the back of the machine holds the power and keyboard cords when the machine is carried. It also hides a panel with the power switch and fuse, as well as all external connectors. A small plastic panel on the underside of the machine can be opened to tilt the screen up at about a 15-degree angle.

A parallel printer port and a serial port configured for a modem are standard. Two modular jacks next to them are used to connect the keyboard and an optical mouse available as an option. An RS-422 port can be added, allowing the machine to be tied into a multi-user or local area network system; however, it is best to order it with the computer, as fitting it later is quite difficult. The parallel port is configured exactly like the printer port on the IBM PC so that the same cables and printers may be used with it.

A dip-switch on the back panel allows the user to set a number of options: baud rate for the serial port, whether the machine will run as a remote workstation or as a stand-alone, whether the screen will show light characters on dark or dark on light, and operation at 60 Hz AC or at 50Hz for use in foreign country. This last makes it one of the few computers to provide a way to use the machine overseas without an adapter. A separate switch selects 115 or 230 volts. Most of these, except voltage and line frequency, can also be set or overridden under software control.

The screen uses an unusual yellow-green phosphor and has a graphics resolution of 640 by 240 pixels—25 percent greater than an IBM PC in high-resolution graphics mode. Text is displayed on 24 lines of 80 characters. Both text and graphics are sharp and easily readable without strain. There is a brightness control on the front panel.

A 6-foot coiled cable connects the keyboard to

the back of the computer; this will let you move it only about 3 or 4 feet from the screen. This is not a great handicap, as the relatively small screen size makes it unlikely that anyone would want to sit much farther away than that.

The keyboard has the layout of the IBM PC keyboard, although the keys themselves are quite different both in feel and in shape: There are ten function keys on the left; a group of keys at the right functions as the cursor pad or the numeric keypad, as selected with a "Num Lock" key. Some of the keys do nothing, but are present only so that the same keyboard can be used for an IBM compatible version to be introduced in 1984. The "ALT" key, for instance, has no effect at all except when used with the "Control" and "Delete" keys to reset the computer; there is no "Reset" button.

Two flip-up legs under the keyboard tilt it at a slight angle for easier typing. All keys have an auto-repeat feature and have both audible and tactile feedback; it is noticeable but not overwhelming. Unfortunately, there are no lights to indicate when the "Caps" and "Numeric" locks are engaged.

The computer emulates the popular TeleVideo 950 terminal in almost all respects, and software configured for that terminal will run on it without modification. However, since the keyboard layout is very different, many of the TV-950 special purpose and function keys are duplicated with shift and control codes. This can be confusing with some software. The TPC-I is also functionally identical to the TeleVideo 803 desktop computer, and any software configured for one will run on the other.

The 32K of independent graphics memory and high screen resolution give this computer graphics not often found in the 8-bit CP/M world. TeleVideo was in fact the first company to offer the GSX graphics system from Digital Research with CP/M-80. This should mean that a wide variety of graphics software will become available for the TPC-I as this standard is adopted by more and more software designers.

Software supplied includes the CP/M 2.2 operating system with the GSX graphics extension and a number of additional utilities for fast disk copying and for configuring the system. Also supplied are a word processor called *TeleWrite* and a spreadsheet program with integrated graphics called *TeleCalc/TeleChart*—actually *Memoplan* and *Chartplan* from Chang Laboratories, as configured for the TeleVideo 8-bit computers.

TeleWrite, which is described as an "Executive Word Processor" in the literature, is not really suitable for more than quick and simple documents

with little formatting. It does offer split screen handling of two documents simultaneously, but this is not enough of an advantage to make *TeleWrite* adequate for most purposes. With the wide variety of better CP/M word processing programs around, many users will probably not even bother to learn it.

TeleCalc/TeleChart, on the other hand, is a very capable menu-driven spreadsheet program which makes excellent use of the TPC-I's graphics. It produces extremely sharp line, bar, and pie charts from tables directly onto the screen and allowing you to print them on dot-matrix printers such as the Epson or Okidata.

A set-up program that comes with the TPC-I makes it possible to set a number of hardware and software options directly from a menu. These include configuring the serial port, attaching or detaching a mouse, changing the I/O byte (several protocols can be selected in this manner for a serial printer), and setting an Autoload file name to be executed automatically on a cold boot. The configuration can be saved temporarily or permanently on the current disk.

A "Time Of Day" program is also supplied, which sets a system clock to the current time and date, as in CPM-86. This clock will keep approximate time as long as the computer is not cold-booted, and can display it once or continuously; however, TeleVideo provides no information about how to access it from a program, so its usefulness is limited at present.

Documentation is minimal, but what there is is very good. In addition to a combined user's manual for *TeleWrite* and *TeleCalc/TeleChart*, you get a brief manual explaining how to set the system up and get started with CP/M. A more extensive "System Reference Manual" gives programmers information on how to use the system's features and options. The manuals are clear, amply illustrated, and well-written. The standard CP/M manuals are not included but are available from TeleVideo dealers.

The TeleVideo TPC-I is somewhat more expensive than a number of the computers with which it would most likely be compared—Kaypro IV and Morrow MD-3, for example. This is somewhat misleading, as the TPC-I is not really meant to be a home computer, but rather a portable element of a small business system, such as one in an office using other computers or a TeleVideo multiuser network.

As a stand-alone system, however, the TPC-I's superior graphics capabilities and the wide variety of software available configured for TeleVideo

equipment make it an excellent low-priced alternative to 16-bit computers for many applications.

TeleVideo, \$1,699 with one disk drive; \$1,999 with two disk drives

THE TRS-80 MODEL 100 COMPUTER

Amid almost daily introductions of new computer models during 1983, the Model 100 was one of the very few that caused a stir and, in effect, set a new standard for others to shoot at.

There had already been "portable" computers, of course, but almost anyone who has been forced to lug a machine of the Osborne/Kaypro/Compaq weight class has been forced to wonder whether they really justify the word "portable"; "transportable" or "movable" might be better descriptions. And, beyond weight and bulk, there is the problem of power. Unless an outlet is available, you need a battery pack that adds to your cost and burden.

Then, along came the Model 100, weighing under four pounds, and not much bigger than *Webster's Seventh New Collegiate Dictionary*. The Radio Shack Model 100 Portable Computer, which Tandy also refers to as the Executive Work Station, has an 8085 8-bit microprocessor and includes 8K RAM and 32K ROM (8,000 characters of random access memory and 32,000 of read only memory), but can be purchased with 32K RAM and 32K ROM.

The ROM contains a remarkable little word processor (Text), a Microsoft BASIC interpreter, an appointments program, a name and address file, a smart terminal program for communications, and an operating system.

The hardware includes a builtin, direct-connect modem, a connector for a parallel printer, an RS-232 (serial) interface, a cassette interface, a place to plug in additional ROM, and a bus for future peripheral connections.

These attributes, not necessarily remarkable in themselves, become little less than astonishing when contained in a computer that weighs just 3.9 pounds and has a 40-column-by-8-line liquid crystal display adequate for programming or word processing. This is light enough to use while commuting to work on the train, in your car or boat, or almost anywhere. (Some airlines allow it, others ban it out of fear that it might interfere with flight or navigation instruments, though the FAA has found no evidence that it does so.) This review is in part being written on a Model 100 while the author leans back in a swivel chair, the mighty midget on his lap and his feet propped on a desk. Nice.

But size alone does not explain the Model 100's

success. It also has some integrated software and hardware features that would be sophisticated in a micro of any weight.

Recent emphasis in advanced developments has tended to focus on features that make computers easier to use: The Epson QX-10 Valdocs keyboard with related integrated software; "shell" programs that substitute easy-to-use menus for the complexities of the disk operating system; and software packages, such as Lotus' 1-2-3 and VisiCorp's *Visi-Sion*, that combine several general purpose applications such as word processing, a database manager, and a spreadsheet program into one easy-to-use package with consistent commands.

On a smaller scale, the Model 100 incorporates a surprising measure of these principles and features.

The first of these greets you when you turn the machine on. The display shows the time, day and date, and the amount of free RAM available. It does not ask, it informs.

Also on the screen is a directory of all the computer's programs and files. The arrow keys control the movement of a cursor on the display. To load a program or a file, simply place the cursor over the desired item and hit the Enter key.

For example, suppose we had previously used the *TEXT* word processing program to create this review and had saved it under the file name OMNI.DO. Now if we want to see it again, we simply place the cursor over the filename OMNI.DO and hit the Enter key. The Model 100 knows the file is a Text file, so it first activates the *TEXT* program and then displays the file.

Had we wished to create a new file, we would have placed the cursor over *TEXT* on the main menu and hit the Enter key. Calling a BASIC program or the BASIC interpreter to write a new program is handled in a similar manner.

In addition to a full-sized keyboard there is, across the top of the keyboard, a row of 16 keys grouped in four sets of four keys each. The leftmost eight keys are special function keys. You can "define" these keys to execute a sequence of keystrokes according to your need.

Using this capability, a fairly good programmer can set up as many as nine programs, a main program and eight subprograms, that function as a unit—that is, any time one of the special function keys is pressed during execution of the main program, the appropriate subprogram is called out; on exit from the subprogram, the main program resumes at the point where it was interrupted by the special function key.

When using the builtin software contained in the

ROM, the definition of each function key depends on the program you are currently using. Now this could be confusing, for it could be a whole new set of things to memorize. But with the Model 100, the current definition of the keys is displayed on the bottom line of the screen just opposite a number corresponding to the defined key. Thus, if you are using the word processing program, Special Function Key 1 is defined as the Find key, and the screen will show the word "Find" opposite the numeral 1 engraved on the frame of the screen. To find the next occurrence of a particular word in your text, you just hit the "1" key, type in the word you wish to find, and the mighty midget locates it.

If you change programs, for example, from the text processor to the telecommunications program, the keys are reassigned to different functions, and the new functions assigned are displayed on the bottom line of the screen.

There are also four keys labelled Paste, Label, Print, and Break/Pause. These are effective in almost every mode of operation.

To illustrate the use of these keys, let's suppose we have just written a letter to a new contact using *TEXT*. While we are at it, we would also like to add her name and address to our file of contacts (contained in a file called *ADRS.DO*).

The Label key turns "on" or "off" the display of assignments to the special function keys. If they are currently "off" (not displayed), we hit the Label key, and the current assignments are shown on the bottom line of the screen.

We see that while we are using *TEXT*, key 7 is assigned the Select function. By hitting key 7 we can define, using a reversed contrast display, material we wish to cut (delete) or copy (to a reserved area of memory). We give the necessary key commands to define the block containing the name and address of our correspondent and then hit key 5, the Copy key. Now we hit key B, the Menu key, put the cursor on *ADRS.DO* (the file in which we want the name and address placed) and hit the Enter key. That file is immediately displayed in *TEXT*—that is, the same word processing program is being used to keep our name and address file so all of the commands are the same.

We can now place the cursor at the point within the file where we want the new name and address inserted and hit the Paste key. The program recalls the name and address that we saved with the Copy key and "pastes" it to your file. Copying and pasting can be done between almost any files; you can even "copy" between a BASIC program you are editing and a text file.

The Print key does what you would expect: It

sends the text on the display to the printer; with the Shift key, the Print key sends the entire text then active in memory to the printer.

The Pause/Break key operates in similar fashion. Without the Shift key, the Pause/Break key causes whatever action is then underway to pause until a key is again hit; with the Shift key, the action is halted completely.

The final four keys in the top row are the Arrow keys that maneuver the cursor. If there is a flaw in this machine, it is here: The Arrow keys seem incorrectly arrayed. Ideally, these should have been arranged in a diamond pattern with the Up-Arrow on top, the Left-Arrow to the left, and so on. With the Arrow keys in a row, many people will intuitively hit the wrong key nearly every time.

The built-in text processor's commands are learned in a few minutes, and anyone could become proficient in a short time. It is not the equal of an all-encompassing word processor in features and power—and it is to Tandy's credit that it generally uses the term "text processor" so as not to overstate or mislead. But for portable use, it is more than adequate. For those who do need more capability, it seems likely that add-on ROM memory will be available soon with greater word processing capability.

The built-in smart terminal program is also easy to use and contains surprisingly powerful features. You can use one of the special function keys to find, for example, the number for the Dow Jones News/Retrieval Service in your address file. Another special key will automatically dial the service for you. And if you have taken the trouble to prepare a short code sequence, the program will automatically handle the sign-on password protocols for you.

If you do not use telecommunications yet, the terminal program will also serve as an auto-dialer for your frequently dialed numbers. Just hit the Find key, type in "joe," for example, and it finds Joe's number; hit the Call key, and it will dial Joe for you.

The files for addresses and appointments are prepared with the text processor. Subsequently, they may be searched or printed by calling the appropriate program from the menu, or edited by calling the file into the text processor.

The same kind of integration extends even to programming in BASIC. If you want to edit a line of the program, just type EDIT 10, for example, and the Model 100 pops your line 10 into the *TEXT* mode in an instant. To edit the entire program, just type EDIT. When you are through, a special function key returns you to the BASIC mode.

The extended BASIC provided with the Model 100 is a powerful implementation of the language. One unexpected feature is its graphics commands. These, in conjunction with the 240-by-64 pixel screen resolution, allow the creation of some respectable business graphics displays.

The ROM that comes with the Model 100 has no calculator or spreadsheet programs—which would have been nice additions for business use. But again, there may be an optional ROM with a spreadsheet of the VisiCalc type for the future. When an additional 32K ROM is made available as an option, the software allows switching from one to the other.

There is also a port for a bar code reader, and this conjures up visions of such things as taking inventory. How easy it would be to run the reader over the item, entering the quantity and later uploading the results for the whole store to your main computer to update the inventory. Or how about copying a BASIC program, printed in bar code, from a magazine?

Up to the limit of installed RAM, programs and document files can be stored in the available memory and transferred to some other media at a later time. Even if the four penlight batteries, which power the Model 100, discharge to the point that the computer will not operate, your files are retained by the built-in nickel-cadmium battery (which is recharged by the penlight batteries and/or an AC adapter) for a minimum of eight days.

But it is not difficult to fill 32K RAM. What then? The Model 1 is equipped with a cassette port that will allow files or programs to be saved on cassette tape using many popular cassette recorders. By way of the built-in modem and Telcom software, files or programs can also be transferred to another computer system. Or with a special connector (a null modem connector), files can be transferred to another computer via the RS-232 port, which permits transfer at higher speeds, frequently limited only by the receiving computer's capability. And it seems almost certain that Radio Shack, or some third party supplier, will soon provide some means of connecting external disk drives.

The TRS-80 Model 100 allows the busy executive to easily carry a computer home or elsewhere for the work he or she needs to get done in odd places and at odd moments. For others it may be an "easy-to-acquire-and-use" first or only computer. It certainly seems a natural for college students and reporters.

When introduced, the Model 100 did not have any reasonably close competitors in size, weight,

and overall capability. It was immediately followed by NEC's comparable model and we will undoubtedly have even more soon. Many new entries, each striving to outdo the previous models, can be expected.

However, if you have a need and find a computer that works for you, you should get it and start using it—and if it's a 100, you will have company. Tandy's initial production order for the 100 was for a quantity of 350,000 and it has justified their confidence. It is selling well.

The operator's manual for the 100 is reasonably well written and is generally oriented to the novice user. It does fail to provide some kinds of information that would have been useful, for example how to transfer files to a non-Radio Shack computer.

It's difficult for a country boy, who became an engineer with a slide rule never more than an arm's length away, to get used to having on his lap the kind of computing power once associated with a room full of monstrous equipment. That's what joy is, and many Model 100 users share it.

Radio Shack, Model 100 with 8K \$799; with 24K \$999

ZENITH Z-160

The Z-160 PC by Zenith Data Systems is a portable version of the desktop Z-150 PC. It uses the same architecture and boards, and is electrically identical. The only difference is the exterior package.

Like the Z-150, it was designed to run IBM PC applications software straight from the box, with no modification. Tests indicate that virtually every software program made to run on the IBM will run on the Z-160. The only exceptions appear to be programs in *GW BASIC* and *BASICA*. This means that there are hundreds of good programs ready to run on this machine. Zenith Data Systems engineers have run more than 175 of the best-known programs and found no problems.

The Z-160 features pop-up disk drives, an interesting innovation. When the machine is carried, the drives fold into the top of the cabinet. When it is placed on a desk for operation, they conveniently pop up out of the top. The keyboard is detached and, in carrying, fits into the front of the cabinet. A solid metal carrying handle turns down to serve as a cabinet support when the Z-160 is in use. The design is good on all counts.

Portability and carry-ability are two different things. The Z-160 certainly is carryable. But one wouldn't want to carry it very far: the two-drive version weighs 33 pounds, about 10 pounds less than

the desktop model. To be truly portable, a unit probably should weigh no more than 16 pounds. On the brighter side, the weight indicates that none of the quality construction of the desktop model was sacrificed to make the portable model.

Overall size of the box ready to be carried is a little more than 19 by 19 inches, by 8 $\frac{1}{3}$ inches high. The case is made of metal, making it durable.

Screen size is a major consideration in portable models. The Z-160 comes with a 9-inch amber display that is easy to read and use, even for those accustomed to the larger standard screen. If you need one, you can have a color display installed.

Nice features include smooth scrolling, booting from either drive, and a choice of four on-screen type styles.

Single-drive and dual-drive models are available, using 5 $\frac{1}{4}$ inch standard IBM format double-sided, double-density disks that store 360K each. At present, there is no hard-disk model.

The Z-160 comes with 128K of RAM, which is expandable to 360K on the main board, and can be run up to 640K with the addition of another board. As in the Z-150, four IBM-compatible slots are open for the addition of memory and peripheral boards.

None of the features of the desktop Z-150 have been sacrificed, a fact not true of many mini-models. The portable has the redesigned keyboard, which has all the keys where a touch typist can use them without relearning his/her typing skills. There is no hitting the back slash key when you intend to hit return, because these keys have been relocated—or rather, put back where they were on the good old Selectric keyboard.

The keyboard has 10 function keys and a numeric keypad with 17 keys, including a convenient Enter, in addition to the standard 57 alphanumeric keys.

The Z-160 also has three ports for connecting peripherals: two standard serial ports and one Centronics-compatible parallel printer port already in

place. You won't have to buy additional boards to get these features.

Printer compatibility is good. Those printers that are compatible with the Z-160, supported by both hardware and software, include the Zenith/Heath Z-25 and Z-125; Diablo Models 630, 1610, 1640, and 1650; the Epson MX80; the DEC LA34 and LA36; the Texas Instruments TI810; and the Heath H14.

Upgrading of the Z-160 through the addition of new boards, such as the 80186, is the same as the Z-150. In a sense, both machines are strong members of the current generation of microcomputers that can be converted to the next generation by the easy insertion of new boards. This may save owners from buying whole new systems in the future.

Service is made relatively easy through the use of plug-in components which can be replaced quickly, cutting service time considerably. Getting quick service may depend on your location. In some major cities, like Chicago, radio-dispatched service is available through independent contractors, who appear at your door in four hours or less. Service is available on a carry-in basis at approximately 150 Heathkit stores located around the country. If neither of these services is near you, repairs will depend on your dealer, who may or may not have his own service facilities. If not, he may have to send the equipment to the nearest Zenith facility, which could take from several days to a week.

The Z-160 is ruggedly built and, if experience with other Zenith Data Systems products serves as a guide, shouldn't require service very often. Owners of Z-89s and Z-100s report less than one service call per year on the average.

The Z-160 is delivered with MS DOS and diagnostic software.

Zenith Data Systems, single-drive model \$2,799; dual-drive model \$3,199

TERMINALS

A Note on Pricing: Many makers of computer terminals do not usually sell their products at the retail level, but in large quantities to commercial users. It therefore proved impossible to provide suggested retail prices for many of the terminals listed in this section. Some manufacturers, such as Radio Shack, Heathkit, and a few others, do produce terminals intended for retail sale to private customers, and the prices of those models are listed. The prices of other units may be obtained on an individual basis from manufacturers, distributors, and some retailers.

AMPEX TERMINALS

Ampex offers a line of terminals that can emulate almost any other company's equipment, and can therefore fit neatly into virtually any office environment. The Ampex D1215 terminal, for example, offers resident emulation of 18 other terminals: the ADDS Regent 20, Regent 25, and Viewpoint; the DEC VT-52; the Hazeltine 1400, 1410, 1420, and 1500; the Lear Siegler ADM-3, ADM-3A+, and ADM-5; the Soroc IQ120 and IQ120C; and the TeleVideo 910, 910+, 912, and 920. The D125 features eight resident international character sets, a non-volatile memory for permanent storage of configuration parameters; a detached keyboard with coiled cable; 12 function keys; one page of display memory; an audible keyclick; line graphics; and built-in firmware that can be easily customized.

Two other Ampex terminals, the D150 and the D175, are similar to the D125 but have extra features, including 20 function keys and 2 pages of display memory, and an IBM Selectric-style keyboard with 16 more keys than you get with the D125. Additional features of the D150 and the D175 include double-height and double-width characters, split-screen capabilities, smooth scroll, and block graphics, along with 15 line-drawing characters. In addition, the D150 and D175 can also emulate two additional terminals: the TeleVideo 925 and the TeleVideo 950.

Ampex Corp., D125 \$679; D150 \$849; D175 \$869

APPLIED DIGITAL DATA SYSTEMS ("ADDS")

ADDS Viewpoint terminals run the gamut from supersmart, full-color models to fairly dumb units that can send and receive information but can't do much more.

The most full-featured ADDS color terminal, the Viewpoint/Color, can produce eye-catching dis-

plays using eight foreground and eight background colors. The colors—red, green, blue, yellow, cyan, magenta, white, and black—can obviously make a report more exciting, and ADDS claims that a colorful screen can also improve comprehension and lessen operator errors. With the VP/Color terminal, you can use color to highlight headlines and subheads, and you can arrange numeric data in color columns and create color charts. In documents prepared or displayed on the VP/Color terminal, you can use color to highlight important words, phrases, or blocks of text. You can even make words, figures, or screen windows flash on and off for added emphasis.

The VP/Color terminal has a detached keyboard with 16 programmed function keys, and a monitor that can be tilted 20 degrees and swiveled a full 360 degrees. The terminal has a line-drawing graphics mode, and can drive a local printer.

Two other ADDS terminals, the 13-inch Viewpoint/78 Color and the 12-inch Viewpoint/78 without color are specially designed to be compatible with IBM's 3271-2 controller and 3278-2 terminal; even their keyboards are IBM-compatible. On the Viewpoint/78 with color, up to four colors of text can be displayed against a black background. The 78 without color comes with the screen color of your choice: a green or white screen is standard, and amber or smooth white are optional.

The ADDS line of monochrome monitors also includes the Viewpoint/90, the Viewpoint/60, and the ADDS 3A/Plus.

The Viewpoint/90 comes with 2K of ROM that can be expanded to 4K. User programs can be stored in a host computer and downloaded to the VP/90, as long as they don't exceed the terminal's memory capacity.

The VP/90 has 15 user-programmable function keys that can be used with the shift key to provide a total of 30 programmable functions. Once the function keys have been programmed, their functions can be stored in a battery-powered non-volatile memory. Other keyboard features include an 18-key numeric keypad, and a user-selectable audible keyclick.

The ADDS VP/90 has a 12-inch screen that can be used with horizontal scrolling to display up to 132 columns. The unit also offers a horizontal split-screen feature.

The ADDS Viewpoint/60 has a detached keyboard, a two-position tilt screen, text highlighting features, line-drawing graphics, and local print capability. The VP/60 also offers 8 programmable

function keys, for a total of 16 functions that can be programmed by the user.

The ADDS 3A/Plus terminal is an unintelligent model that can display, but not act on, data received from host computers. It has a 12-inch screen that can display characters in either standard video—against a dark background—or in reverse video, the other way around. The 3A/Plus keyboard has a 14-key numeric pad and a clear-screen key.

The main feature of the 3A/Plus, though, is compatibility. It will fit right in with Lear Siegler's ADM 3A, and it also offers some compatibility with the TeleVideo 912 and 920, the Soroc IQ-120, and the Lear Siegler ADM 5.

The ADDS A1 and A2 terminals are similar to 3A/Plus. But they offer three function keys, are compatible with other ADDS terminals and are capable of handling more languages. All ADDS terminals communicate at rates between 110 baud and 19.2 kbaud through RS-232 ports.

Applied Digital Data Systems, Inc.

THE BEEHIVE ATL-004 AND ATL-008

Business is buzzing at Beehive, a terminal manufacturer in Salt Lake City, Utah. Beehive offers a pair of sleek new terminals that are about as smart as any on the market, and offer a host of useful and interesting special features, too.

Both Beehive terminals—the ATL-004 and the ATL-008—are designed to be compatible with the DEC VT-100. And both are equipped with tilt-and-swivel anti-glare monitors, low-profile keyboards, powerful microprocessor chips, and a generous supply of RAM and ROM. The ATL-004 has 2K of non-volatile memory and 10K of RAM. The ATL-008 comes with a 32K memory that can be boosted to a whopping 128 kilobytes—a capacity exceeding that of many personal computers, and rarely found in a computer terminal.

The ATL-004 is built around the Intel 8085A-2 processor, while the ATL-008 uses an even more sophisticated chip, the 16-bit Motorola MC68008. Both terminals have 14-inch screens with lines of user-generated text, plus a status line and a line labeling the current functions of a set of user-programmable function keys. The screen labels can be changed to reflect the current functions of the function keys. Screen brightness is controllable at the keyboard. Both units also offer fully programmable communications facilities, with up to 19,200 baud rate.

Thanks to its sophisticated microprocessor, its advanced architecture, and its generous memory, the ATL-008 can generate windows on its screen—a nice touch if you want to work with data from several sources at the same time. And the ATL-008 offers up to 12 pages of screen memory.

Each Beehive terminal has 94 keys, 8 of them programmable on a low-profile keyboard.

There are also 16 pre-programmed function keys, a separate 14-key numeric keypad, and a self retracting cable for easy movement of the keyboard. An auxiliary port provides for a wide variety of protocols for printer support.

Special features of the ATL-008 include double-width and double-height letters; fixed and variable tab stops; and 255 user-defined functions that can be activated via the keyboard. An extra-cost option of the ATL-008 is 2K of non-volatile memory in which the functions of user-defined keys can be stored.

There's one more addition to the ATL-008 that may be of interest to you or your company: a password security system to prevent unauthorized access to information at a terminal. When you have password protection, people who don't know the password can't get at your data. So, if you have some secrets you want to keep, it might be a good idea to take a look at the ATL-008.

Beehive

CTI TERMINALS

CTi, of Raleigh, N.C., offers an unusual pair of special-purpose terminals—the 1000A, designed to work with IBM's Model 2740 and 3767 keyboard-equipped printers, and the Financial Terminal System, which is especially designed for use with financial data.

The CTi 1000A offers local storage of printing formats, with 15 function keys that can be used to recall the formats that have been stored in the unit's memory. The 1000A is said to be fully compatible with software written for IBM's 2740 and 3767 printers and with both printers' communications lines and protocols. So the unit can be used to upgrade or add on to 2740/3767 networks, according to the manufacturer. The 1000A has a 12-inch green screen with a nonglare faceplate and a 24-line by 80-character text display. The typewriter-style keyboard is movable and is attached to a 5-foot cable, and has tactile feedback and selectable audible click. A 10-key numeric pad is built into the keyboard, making input of numeric data a snap.

The CTi Financial Terminal System has two unusual and important features. Like the CTi 1000A, it can also store formats locally, simplifying data entry to a matter of just filling in blanks. And, thanks to a special on-board microprocessor, the Financial Terminal System can also monitor entries for errors. If an operator makes an entry that appears to be incorrect, the terminal generates an error message, reducing the possibility of incorrect information being transmitted. These features can make the CTi Financial Terminal System a useful addition to computer and terminal systems used in financial applications. The unit is small, too, taking up only 1.8 square feet of desk space.

CTi Data

DIGITAL EQUIPMENT CORPORATION (DEC)

Digital Equipment Corporation—better known as DEC—has a new line of terminals designed to offer many of the functions of its famous VT-100 display terminal, but at a lower price. DEC calls its new terminals the VT-200 series, and says it expects them to outsell the original VT-100 line.

The terminals in the VT-200 series are completely compatible with DEC's VT-100 units; they can use the same software, and they're cosmetically compatible with their predecessors, too. So they can be installed quickly and conveniently in offices already equipped with VT-100 models and can work side by side with the older terminals.

The DEC VT-200 family includes terminals that can handle both text and graphics in both monochrome and color.

The VT-220, for example, is a monochrome unit with 12-inch monitor with green, white, or amber letters. It can generate and display both text and bit-mapped business graphics.

The VT-240 is a monochrome system made up of three parts: a keyboard, a separate monitor, and a module containing most of the system's logic circuitry. The VT-240 supports two high-level graphics instructions sets: The DEC ReGIS set and Tektronix's 4010/4014 graphics protocols. And a large number of application packages for the VT-240 system are being developed by third-party vendors, DEC says.

Another new terminal, the DEC VT-241, includes all of the features of VT-240, plus high-resolution color. The VT-241 system includes a 13-inch RGB ("red/green/blue") color monitor, plus an RGB output that can be used with video equipment such as color videocassette records, color cameras, and

other RGB monitors. And the VT-241 system can be ordered with an optional integrated modem with both auto-dial and auto-answer capabilities.

All of the terminals in the DEC VT-200 series offer standard and reverse video, character highlighting, and separate adjustments for character brightness and video contrast.

DEC's new terminals come with a 103-key keyboard with special function keys that are user- or host-programmable to define an operation or command with a single keystroke. The keys can be custom-labeled for added convenience. Special character sets can be downloaded from a central computer to DEC terminals; there are special character sets for foreign languages, mathematics, and other applications. Each VT-100 terminal is available with a choice of 16 different language keyboards, and all of the terminals have printer ports as well as communications interfaces.

DEC says it has sold half a million VT-100 terminal systems since 1978, and expects to sell even more VT-200s in the years to come.

Digital Equipment Corp., VT-220 \$1,295; VT-240 \$2,195; VT-241 \$3,195

HAZELTINE TERMINALS

Compatibility at lower prices: that's what Hazeltine says its terminals offer. The terminals in the Hazeltine line offer a number of special advantages, too, such as increased graphics abilities and larger displays.

The Hazeltine Executive 10/102G is compatible with DEC's VT-100, VT-101, VT-102, and VT-131 terminals. It also has a big 14-inch monitor that tilts, swivels, and can display up to 132 columns of text across its screen. The 10/102G has a low-profile keyboard conforming to DEC terminal standards and including a separate numeric keypad, four function keys, and audible keyclick.

The Executive 10/102G can be used in a special Tektronix graphics mode, and when it's in that mode it can run *Plot 10* software and other graphics software written for TEK 4010/4014. In addition, the 10/102G has a native graphics mode that allows the user to draw arcs and fill in graphic areas. The 10/102G is equipped with a local graphics memory that can store and display either Tektronix graphics or native-mode graphics, either individually or mixed together.

The Hazeltine Executive 10 is a 12-inch terminal that offers a horizontal split-screen display. Other features include video highlighting, line drawing, an on-screen status line, and eight programmable function keys that can be used with shifting for a

total of six functions, all downloadable. The Model 10 emulates the Hazeltine 1500.

Hazeltine has two terminals designated as the Esprit III. There's the plain Esprit III, a monochrome model, and the Esprit Color Terminal III, which includes all of the features of the standard Esprit III, plus dazzling color.

The Esprit Color Terminal III combines color display features of both the Esprit III monochrome terminal and the TeleVideo 950. The Esprit Color III is compatible with existing Esprit III software, so a large number of Esprit monochrome programs, including line drawing, can be run on the color system with only minor changes.

The Esprit Color III has a 13-inch screen that can display text and line graphics in red, green, blue, yellow, cyan, magenta, white, and black. There are 22 user-definable function keys. A useful option is an adjustable display memory size that allows the display of 24-line pages, 48-line pages, or 96-line pages on the screen. And, with a user-installable chip, you can even call up functions that you've custom designed.

The Hazeltine Esprit II is a buffered terminal that has a 12-inch screen and can emulate the Hazeltine 1500, the Regent 25, and the Lear Siegler ADM-3A. A bi-directional auxiliary port allows you to print hard copy or add data recording devices to the terminal, with a local print option.

The Esprit 10/78 is Hazeltine's IBM 3278 emulator. When used with a protocol converter, the 10/78 can perform 3278 applications without any software changes, Hazeltine says. Another Hazeltine terminal, the Esprit 10/51, can emulate the IBM 5251 terminals; it even has the same kind of keyboard. With the help of a protocol converter, you can make the Esprit 10/51 work like an IBM 5251 with no software changes when operating in an IBM System 34 or System 38 environment, according to Hazeltine.

Still another terminal in the Esprit series, the Model 10/25, offers 132-column text-display capability, 16 programmable function keys for a total of 32 functions, programmable double-width and double-height characters, and a tilt-and-swivel monitor holding a 14-inch screen.

The Hazeltine ESP 631 emulates the TeleVideo 925/910 Plus, the ADDS Regent 25/Viewpoint, and the Lear Siegler ADM-3A, as well as other Esprit terminals. The 6310 has a four-page display memory option, a tilt-and-swivel monitor, and a 14-inch video display unit.

There's also a terminal called simply the Hazeltine Esprit. It's a one-piece terminal—a keyboard with a built-in 12-inch screen; it can emulate the

Hazeltine 1500, the ADDS Regent, and the Lear Siegler ADM-3A, and all three emulation modes are switch-selectable by the user.

Most of Hazeltine's terminals can communicate at rates of up to 19.2 kbaud, but the basic Esprit works at speeds of only up to 9,600 baud. The plain Esprit's display features include the usual reverse video and editing functions. The Esprit is a buffered terminal.

Hazeltine Corp.

HDS CONCEPT AVT-APL

The Concept AVT-APL combines high-performance graphics with a 132-column text-display capability. The AVT-APL is compatible with the DEC VT-100, and can also use software written for the Tektronix 4013. The full ASCII character set is built into the AVT-APL, along with several alternate character sets, for a total of 512 individual characters. The unit also offers extensive display, editing, and communications features.

The AVT-APL terminal has windowing capabilities and four pages of scrollable memory. And, like the Concept AVT+, it can also interact with three computers at a time, freely interchanging data among them.

The AVT-APL has an ultra-powerful keyboard with 102 keys, including two separate keypads: a calculator-style numeric pad, and a cursor-control pad with left, right, up and down arrows situated in natural, easy-to-reach positions.

The video monitor that comes with the Concept AVT-APL is a tiltable model with a recessed, hooded amber display screen. The keyboard offers simple graphics characters that can be used for creating forms and graphs, plus horizontal and vertical line-drawing commands. An optional shared-printer interface allows several terminals to be hooked up to a single printer, and two optional communications lines can be used to provide either multiple computer connections or connections to various kinds of peripherals.

Human Designed Systems, Inc.

HDS CONCEPT AVT+

The Concept AVT+ terminal, from Human Designed Systems of Philadelphia, is an ANSI-standard terminal that's compatible with the DEC VT-100 and the DEC VT-52—and it does windows, too! The AVT+ has a 12-inch amber screen that can be split up into windows, enabling the user to peek into several different files of information at the same time. And once a set of windows has been

defined, it can be permanently stored in a non-volatile display memory, and recalled whenever needed.

The windowing capabilities of the AVT+ can be used in a number of different ways. For example, you could use one window to save a copy of a program that you're developing, and a second window to execute the program.

The non-volatile memory that is provided with the AVT+ is another terminal-user's dream. Four pages of local memory are standard, and up to eight pages are optionally available. The terminal's memory also permanently stores set-up instructions, so you can configure your terminal just once and never have to worry about remembering your settings. And while you're working at the keyboard, you can switch back and forth between an 80-column and a 132-column display without losing anything that's stored in memory.

An amber phosphor screen is standard on the Concept AVT+, and a white or green etched screen is optional. The screen is direct-etched to eliminate glare, and can provide either a standard or a reverse video display. The screen is tiltable, and has a text display that measures either 80 or 132 columns by 24 lines.

The AVT+ keyboard is ultra-thin with an adjustable angle for ease of typing. And it has an incredible number of keys: 101 in all, including 46—count 'em, 46—programmable function keys. This vast array of keys looks quite intimidating at first glance, but once you start using the AVT+, it doesn't take long to realize that getting familiar with the keyboard is well worth the trouble; once you get used to it, it can significantly reduce the amount of typing you have to do to get what you want out of your terminal.

Other impressive features of the AVT+ keyboard include matte-finish keytops, a volume control on the key clacker and margin bell, and a layout that makes it easy for touch typists to home in on the keys they use most often, including the cursor-control keys. And the keyboard can even follow you around the office, within reasonable limits, thanks to an extra-long six-foot cable, so you can bring the keyboard to where the work is or work where it's most comfortable.

Still another interesting feature of the AVT+ terminal is its ability to interface with up to three computers at once, so that information from all of them can be viewed and worked on simultaneously through windows. In addition, two communications lines can be used to support printers, and an optional shared-printer interface enables several Concept terminals to share a single printer. The

AVT+ has four built-in character sets, and others are optionally available.

Human Designed Systems, Inc.

HDS CONCEPT GVT

Decisions, decisions: Should you buy a high-resolution graphics terminal, or a model designed primarily for the creation of text and low-resolution graphics? Well, you don't have to worry about that question when you choose the Concept GVT graphics display terminal by Human Designed Systems. With the GVT, you can create, display, and print text, low-resolution graphics or high-resolution graphics—and you can switch back and forth between the GVT's low-res and high-res modes at will, without losing any material that you've created.

The secret behind the GVT's versatility is twin memories: one for high-resolution graphics, and the other for text and low-res graphics. The terminal has one page of high-resolution display memory, and four pages of interactive text and low-res graphics, with eight pages optional. Both memories are constantly active when the terminal is in use, but only one can be viewed on the screen at any one time. Resolution in high-res mode is 250 by 512 dots. In low-res and text mode, the terminal can display either 80 or 132 columns of characters on its screen.

The Concept GVT is software-compatible with both the Tektronix 4010 and DEC terminals but offers a number of special capabilities of its own. It goes beyond the Tektronix 4010, adding character erasure, character write-over, memory dump and fill, dotted and dashed lines and hard-copy production (when attached to a printer). With the Concept GVT, you can quickly and easily create low-resolution business graphics such as bar and pie charts. And you can preview and print high-resolution graphics almost as easily.

A 12-inch amber direct-etched, nonglare screen comes with the GVT as standard equipment. A green or white etched screen is also available at no extra cost. The Concept GVT has 43 programmable function keys, and can also be used with a joystick, a trackball, or a mouse. Standard features include a non-volatile memory for permanent terminal re-configuration, and two RS-232C interfaces.

Human Designed Systems, Inc.

HEATHKIT

Remember Heathkit, the company that made radios and hi-fi components that you put together

yourself? Well, the Heath Company is still in the kit-making business, and if you're an electronic gadgee with an evening or two to spare, you can now put together a mighty fine computer terminal from a Heathkit package—and save yourself a bundle in the bargain.

If the Heathkit you decide to assemble is the Model HT-10, you'll wind up with a terminal that will automatically dial any of 27 phone numbers at the touch of a key.

You can also buy the H-29 Heathkit, and when you've finished assembling that one, you'll have the exact same terminal that Zenith calls the Z-29 and sells for \$849. The H-29/Z-29 has a tiltable 12-inch green screen that can be adjusted by 10 degrees for maximum viewing comfort. The H-29/Z-29 also offers underlining abilities, standard and reverse video, brightness control, and a "help" key for accessing helpful hints in software programs. The H-29 keyboard sports a 14-key numeric pad, and little lights that tell you when the power is on, when the caps lock is on, and when other things are happening. The keyboard is capable of producing 33 special symbols, and it has an audible key-click to let you know that you've really pushed a key down. The keyboard is detached and movable, with an eight-foot cable.

Heath Co., HT-10 \$449; H-29 \$599

KIMTRON TERMINALS

What's in a name? Not much, according to Kimtron, a terminal manufacturer in Santa Clara, California. Kimtron has put together an impressive array of terminals that act just like some of the most popular and best-known units on the market. The Kimtron ABM 85H and ABM 83 emulate TeleVideo's 920 and 925 models, the ABM 85H D100/200 works like Data General's D100/20 terminals, and the ABM 85H VT-100/132 emulates the DEC VT-100/132. All of Kimtron's terminals have programmable function keys, and the Data General and DEC workalikes are equipped with a programmable cursor as well.

Kimtron's terminals have labor saving tab-set and tab-clear keys, and margin bells that warn you when you're reaching the end of a line. Another convenient feature, especially for multinational companies and other users who deal with foreign languages, is the inclusion of four international character sets—the German, French, and Spanish alphabets, as well as English letters.

The screens on all Kimtron terminals are nonglare, high-resolution units with 24-line by 80-column displays. You can select a model with a light

green, dark green, or amber phosphor display. And when you sit down to work, you can use either standard video—with bright letters against a dark background—or a reverse-color video display.

Each Kimtron terminal has a detached keyboard with a long (six-foot) coiled cord. The keyboard has 96 keys, with 20 function keys, 8 of which are programmed by the user. There are 14 numeric keys, and 62 letters. The keyboard is laid out like the ubiquitous IBM Selectric typewriter, with sculptured keycaps, and you can either type quietly or engage an electronic key-click circuit that makes the unit sound just like a regular typewriter.

The terminals offered by Kimtron have prodigious memories, too. They can store up to four screens of information in local memory, depending on the model you choose and the options you purchase. The most forgetful Kimtron terminal is the ABM 83, a TeleVideo emulator, which comes with a maximum of two pages of optional memory. A four-page memory comes standard on the ABM 85H TeleVideo emulator, and as an optional addition to the rest of the monitors in the Kimtron line.

Kimtron ABM 85H is a natural mimic, capable of imitating the TeleVideo 920, 925, and 950; the DEC VT-52/100 (with 80-column screen), and the Data General D100/200. The 85H has 16 user-programmable function keys whose functions can be stored in local memory. There are 15 special graphics characters, 32 special characters for use in international character sets, and 20 other special and math symbols. You can scroll through four pages of display data easily. And under the hood of the ABM 85H, there's even room for a custom circuit board so you can soup up your terminal.

The ABM 85H has a 12-inch green phosphor monitor, also available in amber, that's surface-etched to reduce fatigue and eyestrain. The screen can display 25 lines—24 lines of text plus a status line—in either standard or reverse video. The keyboard is detachable and has an integrated 14-key numeric pad. The keys have a tactile touch and keyclick. Communication rates go all the way up to 19,200 baud.

Another popular Kimtron, the KT-7, features lots of adjustments to maximize typing and viewing comfort. The KT-7 has a tilt-and-swivel, 12-inch, nonglare screen, with adjustable height. Even the keyboard height is adjustable to three different levels.

KT-7 keyboard has 20 programmable function keys whose functions can be stored in local memory. The keyboard also includes international characters, line and block graphics, and mathematical symbols.

Kimtron KT-7 comes with one page of local memory, with up to four pages optional. The unit will work with an IBM Personal Computer; it will also emulate TeleVideo's Model 920, 910 and 925 terminals and is code-compatible with the TeleVideo 924, 914 and 950. By inserting an optional chip, you can also make the KT-7 work with ANSI X3.64 to emulate the DEC VT-52/100/132 (80 column), Data General D100/200 and many other terminals. The terminal also has an option that makes it able to use Tektronix Plot 10 graphic software; another option allows the use of a modem for communications.

Service on Kimtron terminals is provided by RCA, a company that has service centers nationwide.

Kimtron Corp., ABM 85H \$895; KT-7 \$575

LEAR SIEGLER TERMINALS

Lear Siegler produces an eminently functional set of monochrome terminals ranging from the very sophisticated down to the most basic, and several models include some truly unique features—such as logically arranged cursor-control keys, local memory storage, detached keyboards with generously long cords, and lots of other extras.

The Lear Siegler company calls its terminals the ADM series—an abbreviation that stands for the "American Dream Machine." That's a pretty ambitious appellation, but the terminals in the LS ADM series really are a touch-typist's delight; their cursor keys, for example, are placed where cursor keys should be, with the left arrow on the left, the up arrow on top, and so on. That's a logical and humane arrangement, and it's just the sort of simple design technique that distinguishes Lear Siegler's "American Dream Machines" from some other terminals, which all too often turn out to be nightmares for touch-typists.

Lear Siegler's terminals have many other features that have proved to be popular among terminal operators. The ADM-11, ADM-12, and ADM-24E, for example, are all equipped with tilt-and-swivel monitors that click into position, and there are no unsightly cables to tug at the monitors while they're being adjusted. The screen sizes of the monitors range from 12 to 14 inches, measured diagonally.

The Lear Siegler ADM-11, -12, and -24E terminals all have detached low-profile keyboards tapered for comfortable use. The cables to the keyboards are six feet long, so you can tote that keyboard over to wherever it's comfortable for you.

The top-of-the-line LS terminal, the ADM-24E, is equipped with an on-screen status line that can be

used to display the functions of the top row of function keys. The 24E comes with up to 22K of display memory. Forty-eight lines of video display memory are standard, and another 48 lines are optional, for a total of up to 96 lines of local video memory. And you can use this memory in any way you like to construct pages of whatever length you need. For example, if you had an ADM-24E equipped with the maximum 96 lines of memory, you could construct a 66-line display format on one page, and use the remaining 30 lines for a second page. And you could scroll backward or forward through the entire 96 lines of stored information at any time.

The ADM-24E, like all Lear Siegler terminals, can be used to generate business graphics. Eleven international character sets, including Spanish and German, are standard. So are 16 user-programmable function keys, all shiftable, for a total of 32 functions. For the comfort of the eyes, the terminal offers a user-selectable light or dark video background, and there's also a reduced-intensity background that can improve readability and save wear and tear on the eyes in some types of applications. A horizontal split-screen function is also standard.

Thanks to dual processors, the ADM-24E has an extraordinarily high IQ for a terminal and is easy to customize. The logic board provided with the terminal offers a generous 56K of memory—more than enough to handle a sophisticated disk-drive controller program or the object code for a BASIC compiler. The 24E's memory space can be used as either RAM or ROM, so you can either run your own programs or download programs from a host computer. The terminal is equipped with logic circuitry that allows custom routines to be flagged and run whenever required, saving valuable operating time. Another Lear Siegler terminal, the ADM-11, can be ordered either with a standard 12-inch amber or green screen, or an optional 14-inch screen available in the same colors. The ADM-11 has four function keys, shiftable to perform eight functions, storable locally. Labels for the functions can be displayed on the 25th status line for fast reference. Data can be printed directly from the ADM-11, and the host can send information directly to the terminal screen, to the printer, or to both. ADM-11 can also recognize a busy signal from the printer and signal the host to stop sending data. Pretty smart, eh? Optional international character sets and a 256-key buffer to prevent any loss of data from even the fastest typist make this a pretty functional terminal.

The ADM-12, a particularly good terminal for financial applications, can store data in a horizontal 158-column by 24-line format to give you a wide

column worksheet. The entire worksheet can be scrolled back and forth across the screen, or each line can be scrolled. A standard two-page memory of 24 lines, giving 48 lines of memory, makes word processing a lot easier. You can also scroll the text up and down. ADM-12 allows you to "lock in" data in one region as a reference, while scrolling through data in another region at the same time. The two-page memory allows you to shift back and forth between two stored pages of data; with this memory ability, the host can transmit up to a 48-line message to the terminal with no data being lost. The 12 has 16 programmable function keys, for 32 functions, all locally storable. Terminal features are selectable from the keyboard, with the features displayed on the 25th status line. The ADM-12 also gives you six edit keys for easy editing.

Both the ADM-3A and the more advanced ADM-5 have a 12-inch green or white screen, 24 by 80 display and data rates up to 19.2 baud. ADM 5 adds a numeric keypad, separate cursor-control keys, upper- and lowercase letters, visual attributes and local editing. Both units have attached keyboards for rugged environments where detached keyboards might be inappropriate, and where space is at a premium, such as classrooms and manufacturing areas.

Lear Siegler, Inc.

LIBERTY TERMINALS

Patrick Henry probably wasn't thinking about computer terminals when he said, "Give me Liberty or give me death"; terminal operators don't usually feel that strongly about their machines. Nonetheless, Liberty Electronics of San Francisco does make two very nice terminals with patriotic names, and if you're really into terminals, the company's Freedom line could conceivably be worth haggling over, if not actually fighting for.

Liberty Electronics kicked off its terminal line in June 1982 with the Freedom 100. Now the company has added the Freedom 200, which offers even more features than its first model. Both terminals have a 12-inch green phosphor screen that has an etched nonglare surface and a 24-line-by-80-character display. The Model 100 has five positions for the screen tilt, from 5 degrees to 15 degrees, and the Model 200 has full tilt-and-swivel capabilities. Both the 100 and 200 can display standard and reverse video.

The keyboard on both models is detached, with the 100 having 93 keys, the 200, 106. The numeric keypad on both models has 0 through 9 plus a

comma, a minus sign, an "enter" function, and a period, with the 200 adding the number "00." On both the 100 and the 200, there are 10 user-programmable keys. In addition, the 200 has 12 command keys that can generate instructions such as "send," "print," "scroll up," and "scroll down."

Both the Model 100 and the 200 have seven foreign character sets, including British, French, Danish, Swedish, German, Swiss, Finnish, and Norwegian.

On the Model 200, you can program up to 20 code sequences which can consume a total of up to 256K of memory—or you can program the terminal to generate up to 20 preprogrammed messages, including passwords, error messages, communications messages, operator prompts, and the like. The Liberty 200 also has editing keys that provide extra tab functions which the 100 does not have.

Other special features of the Liberty 200 include one page of built-in display memory in native mode, with a second page optional, and a standard two pages or more of display memory in an emulation mode. The 200 also has an extended graphics character set of 86 characters, including Greek and mathematics characters, plus 15 graphics characters. The 200 emulates the TeleVideo 950 and the Lear Siegler ADM 31, and is compatible with the Freedom 100. The 100 emulates an even broader array of terminals: the TeleVideo 925, the ADDS Regent 25, the Hazeltine 1420, and the Lear Siegler ADM 3A/5.

These two models are but the first in what will soon become a broad line of terminals, Liberty says.

Liberty Electronics, Freedom 200 \$795; Freedom 100 \$495

LINK

The Smart Link 150, from Link Technologies of San Jose, California, is a TeleVideo 950 workalike boasting a 12-inch, full tilt-and-swivel, nonglare green phosphor (amber optional) screen with a 24-line-by-80-column display. The unit has a detached, low-profile typewriter-style keyboard with 96 characters and 11 function keys that can generate a total of 22 preprogrammed messages. There's also a 12-key numeric pad with comma, minus, and enter. Editing functions are standard, and there are special *WordStar* function keys allowing for easier use of the *WordStar* word processing program. A "WordStar Made Easy" manual and keyboard overlay to make using *WordStar* even more peaceful are also optional. This Smart Link 150 terminal also

has up to four pages of local memory, which is an optional feature. The terminal can be customized for special needs. In addition, it comes with an RS-232C port for linking with a computer or printer.

Link Technologies, Inc.

MICRO-TERM

If you want a terminal that's compatible with most of the name-brand models on the market, but don't want to have to mortgage your house to buy it, then Micro-Term may have just the unit you're looking for. Micro-Term offers a broad line of terminals that can emulate a wide variety of popular models, and the prices of its products are just about as reasonable as you're likely to find anywhere.

One popular Micro-Term unit, the ERGO 201, emulates four popular terminals: Televideo 925, Lear Siegler ADM-3A, DEC VT-52, and Micro-Term's own ACT-5A. And the ERGO 201 can be customized to emulate even more terminals, including models manufactured by ADDS, Hazeltine, and other companies.

The ERGO 201 has 16 function keys that can be programmed from the keyboard, and the functions thus programmed can be saved in non-volatile memory. The ERGO 201 has a 12-inch green screen that can display 24 lines of text, up to 80 columns wide, plus a 25th status line. Two pages of memory may also be added. And you can add a key-click feature if you like to hear the sound of the keys. Like all of Micro-Term's terminals, 201 communicates at a maximum 19.2 kbaud.

Two other terminals from Micro-Term, the MIME-2A and the ACT-5a, are one-piece keyboard-and-screen units that are specially designed for use in rugged environments such as schools and factories. Each model has eight function keys, and both standard and reverse video. Both terminals have a page of local memory.

The MIME-2A emulates the DEC VT-52, the Hazeltine 1500, and the Soroc 1Q 120.

The ACT-5A has a vertical split-screen feature that can enable the user to view two blocks of text or data simultaneously.

Micro-Term calls its DEC VT-100 emulator the ERGO 301. The 301 has both an 80-column and a 132-column text-display mode, and can generate both double-height and double-width characters. You can see 24 lines even in 132-column mode. The screen is 24 lines high, in both its 80-column and its 132-column mode, and a scrolling window can also be used.

Two pages of memory are standard, and so are

four user-programmable function keys. The function keys can be programmed from the keyboard, and their functions can be saved in local memory. With the addition of an easily installable graphics board, the ERGO 301 can be upgraded to accept Tektronix Plot 10 software. Another addition can make 301 compatible with the Tektronix 4010 terminal.

Two more options, available for both the ERGO 201 and the ERGO 301, can provide even more versatile graphics capabilities. Another option adds shading, zooming, and vertical and horizontal scrolling controls, and a BusiGraph mode can provide the ability to draw pie charts, bar charts, and trend lines.

When you want to use the ERGO 301 to communicate with other terminals, a 256-character buffer significantly reduces the possibility of losing data. And the unit's power consumption is a very low 25 watts, making it very inexpensive to operate.

Still another Micro-Term unit, the ERGO 4000, has a fancy screen showing 66 lines of text by 80 characters on a 15-inch display. The screen tilts a full 25 degrees to achieve good viewing angle. It includes 15 function keys loaded from the keyboard or host and they may be saved. For typing—one of the best functions to put the huge screen to prime use—you can set a margin bell, and tabs. There are code sets for ANSI 3.64 terminals and DEC's VT-52. In the ANAI mode, ERGO 4000 emulates most features of DEC's VT-100. The 4000 may also be programmed by the user to emulate other terminals. The keyboard is detached, and, like the other models, includes a separate numerical keypad.

Microterm, ERGO 201 \$795; MIME-2A \$1045; ACT-5A \$995; ERGO 301 \$895; ERGO 4000 \$1195

QUME

There's an interesting angle to Qume's success in the computer terminal market. Qume offers a broad line of good-looking terminals that can emulate most of the popular name-brand units on the market—and, as a special bonus, can add some interesting and useful tilt-and-swivel ergonomics to your desktop.

One of Qume's most sought-after terminals, the QVT-211 GX, emulates the Hazeltine 1500, the Lear Siegler ADM-A/5, and the TeleVideo 910. In addition to the features offered by the rest of the Qume line, the QVT-211 GX boasts a host of extra graphics capabilities, including an independent graphics memory that allows text and graphics to be dis-

played simultaneously. The terminal is compatible with the Tektronix 4010 and 4014 command sets, so it's capable of using Tektronix PLOT-10 graphics subroutines. In addition, the QVT-211 GX can be instructed to draw arcs, circles, boxes, and fill-ins with a single command.

A 14-inch nonglare screen display is standard equipment and an amber screen is optional. Resolution is 644 by 288 dots, with up to 24 lines by 80 characters on a screen in test mode.

The QVT-211 GX keyboard is a detachable unit with as many keys as most users are ever likely to need: 96 ASCII characters, 15 line-drawing symbols for graphics, and an additional 32 for controlling character symbols. Fourteen of the unit's keys are on a separate numeric keypad, and 12 are user-programmable function keys.

The QVT-108, QVT-102, and QVT-103 can't perform the graphics tricks that the QVT-211 GX can, but they do include some of the GX's other useful features, such as the famous Qume tilt-and-swivel screen with a detached keyboard at the other end of a coiled cord. Qume terminals also feature low-profile keyboards that hug the desktop and are as comfortable as they are attractive.

Some models have two pages of local text memory, a distinct advantage when your mainframe or minicomputer is slowing down because of other users' demands.

The QVT-102 has a 12-inch nonglare green screen, and can emulate four other popular terminals: the Hazeltine 1500, the Lear Siegler ADM 3A/5, and the TeleVideo 910.

Another Qume model, the QVT-103, is a popular alternative to Digital Equipment Corp.'s popular VT-100 and VT-131 terminals. The QVT-103 comes with two pages of memory, and more can be optionally added.

Additional features of the QVT-103 include full modem-control capabilities and extensive local editing features, with 14 standard editing functions and 12 user-programmable functions. The QVT-103 has a 14-inch screen that can be used with either an 80-column or 132-column width. The terminal generates sharp, easy-to-read characters that are displayed in a 10-dot by 12-dot format, rather than in the coarser 9-dot by 12-dot matrix commonly offered with other terminals. You can select an 80-column screen or use a 132-column format.

The QVT-108 is a terminal for users who want to emulate TeleVideo models 925, 920, and 912. Its special features include 11 function keys, 22 user-programmable functions, 12 editing functions, and two pages of local screen memory. It also includes a line-drawing graphics characters set. The screen

is a 12-inch nonglare green with amber optional; a 14-inch screen is also an option.

Qume Corp.

RCA ALL-PURPOSE TERMINAL VP-4801 AND VP-3801

Most people, under most conditions, want a terminal with a full keystroke keyboard. Anything less slows down typing and just doesn't feel right. Occasionally, though, a membrane keyboard is called for because it is more rugged and better able to withstand hostile environments—impervious to dust, spilled coffee, or dripping mayonnaise.

RCA will happily sell you its All-Purpose Terminal with either kind of keyboard. The VP-4801 is the full keystroke model; the VP-3801 has the membrane keyboard. They are otherwise identical in price and features. Either is available with or without a 12-inch monitor.

The APT might be termed a full-function communications terminal. It comes with a built-in 300-baud, 103-compatible modem. This can operate in originate, answer, auto-answer, and auto-dial modes in full or half duplex. It can use either pulse or tone dialing as necessary. If you'd rather communicate at 1200 baud, you can connect a 1200-baud modem through the terminal's RS-232 port. You can also use the RS-232 port to connect the APT directly to a computer at speeds up to 9600 baud.

The APT terminal contains a built-in program that makes full use of the modem. Features include the ability to store up to 26 phone numbers and 26 log-on sequences. The auto-log-on feature includes password protection: Once you enter your password in the terminal, no one else can get it out again. If you need special communications parameters for any given system, you can store them along with the phone number and the terminal will set itself accordingly. A built-in, 48-hour, battery-less power backup helps insure against accidental loss of the stored numbers and log-on sequences.

Once online, the APT is a basic dumb terminal with exactly one online feature. It will let you turn a printer on and off, if you have one connected through the Centronics-compatible interface.

Using the APT is simple enough. Everything you can do with it, from entering a phone number or log-on sequence to telling the system to dial a call, is done through menus. These are designed to be simple, straightforward, and self-explanatory. You only have to read the screen and make choices or respond to prompts as appropriate.

The APT makes no compromises with the requirements of a full-sized terminal; it even includes a numeric keypad for easy entry of numbers. But it is also designed to be briefcase-portable. The keyboard unit contains everything but the monitor. It measures 17 inches wide by 7 inches deep by 2 inches high, and weighs in at under 4 pounds. It can be carried from place to place and used with any monitor or TV set. The VP-3801, with its rugged membrane keyboard, is particularly well-suited to this kind of portable use.

The APT comes with free registration for and one free hour on both Dow Jones/News Retrieval and CompuServe.

RCA MicroComputer Products, With monitor \$598;
Without monitor \$399

RCA VP-3501 VIDEOTEX DATA TERMINAL

The RCA Videotex Data Terminal is a distant cousin of the RCA All-Purpose Terminals. As with the APT models, the Videotex Data Terminal is truly portable, not simply transportable. At 17 inches by 7 inches by 2 inches, it will easily fit inside a briefcase. Even better, with a weight of less than six pounds, you will hardly notice it is there. Most important, it is rugged enough to survive the trip.

Unlike the APT models, the VP-3501 comes with a membrane keyboard only. This adds to the system's ruggedness by helping make it spillproof and peanut-butter-and-jelly-proof, but it makes the terminal a bit more difficult to type on.

The VP-3501's standard communications functions are severely limited. It has no built-in communications program, no auto-dial capabilities, and no online features at all. Its most notable features are its abilities to generate color graphics and sound, but few host computers make use of them.

The VP-3501 has a built-in, manual-originate, 300-baud modem, a calculator-style keypad for entering numbers, and a port that will work with any printer equipped with an RS-232 interface. Other options include a cassette-recorder interface to let you record information on tape, and an acoustic coupler for times when you can't use the direct connect modem. You can use the terminal with any TV set.

The VP-3501 comes with free registration for and one free hour on both Dow Jones/News Retrieval and CompuServe.

RCA MicroComputer Products, \$399

THE SANYO CRX 1100

Sanyo's CRX 1100 is a lot smarter than it looks—although it looks pretty bright. To the naked eye, the CRX 1100 appears to be another terminal, albeit very attractive; but it's what's inside that counts, and under the CRX 1100's hood there's a built-in Z80-A computer chip and 8K of ROM, plus another 6K of RAM—and that makes the Sanyo CRX 1100 much smarter than the average terminal.

The CRX 1100 has a detachable keyboard with a large complement of 100 keys, eight of them user-programmable; and, thanks to the terminal's built-in Z80-A microprocessor, and programmable memory, configuring the system is a one-time-only operation. The system needs to be set up just once using the keyboard, and from then on it will remember its proper settings, because they'll be stored in permanent memory.

The screen of the CRX 1100 is a 12-inch nonglare model with an 80-column by 24-line display, and with both standard and reverse video capability. A communications interface allows connection through an RS-232C port, and the terminal also has a printer interface through an RS-232C Centronics port. A tilting mechanism for adjusting the screen angle is also available as an option. In addition, a built-in emulator allows the terminal to use existing data from other types of computers without requiring the information to be rewritten.

Sanyo Business Systems Corp.

SCANSET

Picture an auto-dial telephone with enough memory to hold 36 phone numbers. Now add a screen to display the numbers, and an alphabetic keyboard so you can add names as well. Use small, calculator-style keys so that you only need about two-thirds the width and height of a normal keyboard. While you're at it, add a modem, and set up the system for use as a terminal. Finish off with a connector for an optional printer, plus a few flourishes to control communications parameters, screen brightness and the like, and you should wind up with something very like Scanset.

Scanset is available in several variations. You can get it with or without a built-in handset, automatic dialer, or modem. The modem is available as either a 103-compatible, 300-baud-only device, or as a 103/212-compatible, 300/1200-baud device. If you choose to get it without the built-in modem, you can use it with any standard RS-232 modem.

In any of its variations, Scanset is one barely perceptible step up from a dumb terminal. Its built-in

program allows for automatic dialing, automatic log-on, and the ability to turn an optional printer on or off while online. But Scanset is a dumb terminal with a difference. It uses roughly one-third the desk space of most terminals, or roughly three times the space of a standard telephone.

This small size is one of Scanset's most important features. It means that you can put the unit on your desk without losing much working space. You must pay a price for this, though. Scanset's small keyboard is sufficient for systems like Dow Jones or NewsNet, where most of your typing will be confined to choosing from menus. If you do much typing while online, it will quickly become frustrating.

Aside from this possible problem, Scanset is not likely to frustrate anyone. The unit is clearly designed for ease of use. Many people will be able simply to plug it in and go, with little need for the manual. For the most part, you have only to read the instructions on the screen and do the obvious.

The keyboard includes six Function keys on the top row. The bottom row on the screen displays descriptive labels for these keys. The labels change depending on what the Scanset is doing, but their meaning is always reasonably clear. When you turn the unit on for the first time, you are greeted with an empty phone directory and two labeled keys. The labels are "Dial" and "Next." If you want to dial a number, you choose "Dial." If you want to do something else, add a number to the directory perhaps, you choose "Next." That's about as complicated as the instructions get.

In some ways, Scanset is more of an oversized telephone than a terminal, but this is not necessarily a bad thing. If you don't need a full-size keyboard, and particularly if desk space is at a premium, Scanset is worth considering. If you get it with the handset, you can take your phone off your desk, too. And with or without the handset, it makes a terrific auto-dialer.

Scanset comes with free registration for Dow Jones/News Retrieval and THE SOURCE.

TYMSHARE Equipment Product Marketing, Model 410 (without modem or automatic dialer) \$495; Model 415 (300-baud modem, automatic dialer) \$695; Model 415 (300/1200-baud modem and automatic dialer) \$1295; XL Model (with handset, 300-baud modem, automatic dialer) \$1895

SOROC TERMINALS

Soroc terminals can emulate almost any other popular computer terminal, and therefore can step right into virtually any office, with no software changes necessary for compatibility in either direc-

tion. Standard features on all Soroc terminals include fast transmission speeds of up to 38.4k baud, a standard RS-232 serial interface, and a special communications program called *Modestart*. The current Soroc line, called the Challenger series, is also available with an optional 300/1,200-baud, Bell 212A-compatible modem.

Two popular Soroc terminals are the Challenger 540/AM, which is compatible with Alpha Micro terminals, and the Challenger 540/B4, which is compatible with Basic 4 computers. The C540/AM has 21 function keys, and the C540/B4 has 17. The C540/AM runs Alpha Micro Software, including *Alpha Calc* and *Alpha Writer*.

Both the C540/AM and the C540/B4 have a keyboard layout similar to that of the IBM Selectric typewriter—which is more than can be said for IBM's own personal computer. Soroc says that the Selectric-type keyboard layout makes the transition from a typewriter easier for secretaries. Soroc's keyboards also have cursor-control keys that are placed well away from their built-in numeric keypads, making the cursor keys easy to get to and decreasing the likelihood of errors during accounting and bookkeeping operations.

Both terminals also include *Modestart*, an expanded version of the *Softstart* communications software package. Along with the *Modestart* package, there's an extra 96 bytes of local memory that can be used for permanent storage of log-on sequences and telephone numbers, a feature that saves effort, time, and money.

Another popular Soroc terminal, the C530, features keyboard graphics and 14 function keys. The C540 is code-compatible with the C530, and also has a tilt-and-swivel monitor, 21 user-programmable function keys, and editing and transmission keys.

The Soroc C550, downward-compatible with the C540, provides 32 user functions, plus resident emulations that allow it to be integrated easily into many computer systems. Equipment that it can emulate include Lear Siegler's ADM-1, ADM-2, and ADM-3 terminals, and the Tandem 6510.

Soroc's Model C525 is compatible with the TeleVideo 925. It has 40 reprogrammable function keys, but 22 of them are factory-set with specific codes that emulate the TeleVideo 925. Other features of the C525 include a transmission speed of up to 38.4 kbaud, a Selectric typewriter layout, cursor controls conveniently situated near the typewriter keys, and a *Modestart* communications package with 96 bytes of extra memory.

Soroc Technology, Inc.

TANDY (RADIO SHACK) DT-1

Tandy Corporation, the parent company of Radio Shack, offers a low-cost terminal that can be used with personal computer systems and can also emulate the protocols of four other terminals, with configurations selected from the keyboard. The unit is designated the TRS-80 DT-1.

The Tandy DT-1 terminal can emulate the TeleVideo 910, the Lear Siegler ADM-5, the ADDS 25, and the Hazeltine 1410, with configurations selected from the keyboard. The selected protocol is stored in an EEPROM ("Electrically Erasable Programmable Read-Only Memory"), and therefore remains in memory even when the computer's power is turned off. The DT-1 terminal has an 80-character by 24-line video display, and is equipped with video attributes including normal and reverse video, blinking, underlined characters, and half-intensity video.

The terminal's keyboard has 70 comfortable, full-stroke keys, including the full set of special keys used by the Tandy TRS-80 Model III and Model 16 personal computers. The DT-1 also has a 12-key data pad that can be used in three ways: for numeric data entry, for cursor control, and for special control commands.

The DT-1 is equipped with both a built-in RS-232C serial interface and a parallel interface compatible with Radio Shack printers. Communications speeds of 75 to 19,200 baud are provided. The DT-1 can be used with Tandy Model 16 computers under the Xenix operating system as part of a multi-user computer-and-terminal system.

Tandy Corporation/Radio Shack, \$699

TEC ET AND ET 80

TEC (not DEC) of Tucson, Arizona, has some very positive comments about its ET and ET 80 computer terminals. Both models have positive video displays—dark letters against light backgrounds, instead of the other way around—and that feature, according to TEC, can reduce operator errors by 26 percent. You may believe that, and you may not; some people don't like the blazing brilliance of positive displays. But if conventional CRT displays give you headaches or eyestrain, it couldn't hurt to take a look at the ET or ET 80 terminals manufactured by TEC.

The ET and the ET 80 also have one feature that's definitely a plus: a big 15-inch nonglare screen that displays up to 24 lines of 80 characters each, plus a status/system line. Both models also have a low-profile detachable keyboard with stepped and sculptured keys. And two separate keypads are built into the keypad: one on the right for typing

numbers, and another on the left for moving the cursor on the screen. Sixteen or more (on the ET 80) user-programmable function keys are also provided.

Both the ET and the ET 80 emulate the DEC VT series, and keyboards that work like IBM 3278 and Teletype keyboards are also available.

Editing features that are standard on both terminals include a programmable tab key for variable tab-column widths, and an ability to scroll up to 132 columns of text left and right across the screen.

The video monitor that comes with the ET and ET 80 is extraordinarily versatile. It can be tilted backward or forward, and swivelled to the left or right—even its height can be adjusted. So if you can't find a comfortable viewing angle, you can't blame TEC's monitor!

When you're working at the terminal, you can split the screen either horizontally or vertically, and you can display double-width, double-height characters. You can fine-tune the brightness and contrast for maximum clarity and comfort, as well.

There are a number of important differences between the ET and the ET 80 terminals. The ET allows you to scroll through up to four pages of display memory for local editing. The ET 80 adds another scrollable page, for a total of five. The ET 80 has 18 user-programmable function keys, 2 more than the ET has.

In addition, the right-hand and left-hand keypads on the ET 80 are interchangeable. If you don't like to type in silence, you can activate an end-of-line bell and audible keyclick when you use the ET 80.

The ET and the ET 80 communicate with the world via a standard RS-232C port, at speeds ranging from 50 to 19,200 baud. For users who require more hookups, an auxiliary RS-232C port is available as an option. And, for those who want to use their terminals with printers, there's an optional printer port with a one-page print buffer.

The ET 80 also has an optional RS-449 interface and a bi-directional RS-232C port, and is compatible with the ANSI 3.64 code as well as with standard ASCII characters.

Future options and customization possibilities for TEC terminals include an RSS 422/423 interface and card reader.

TEC, Inc.

TAMPER-PROOF TERMINALS

If you've got a secret—or a whole bunch of them—then TEC may have just the terminal you're looking for. TEC offers two different terminals that can be equipped with elaborate security systems to

keep data thieves away. These two terminals, the Model 630 and the Model 70, are ideal choices for companies or individuals concerned about computer crime.

One TEC terminal in the Series 630 line can be purchased with an optional magnetic card reader; once the device is installed in the keyboard, the terminal can't be made to disclose any data until a properly coded card has been slipped into a card on the reader. The TEC 630-C, as the unit is called when it is equipped with the card reader, was designed primarily for security-conscious users in private industry and government. Users include credit-card companies, airline ticket agents, law-enforcement organizations, and many other kinds of businesses and government entities.

The 630 line of terminals has a 12-inch anti-glare screen, with a choice of a green or amber display. The monitor can generate both standard video (bright letters on a dark screen) and reverse video (dark letters on a light background). The monitor also has tilt-and-swivel ability for viewing comfort, plus user-adjustable brightness. The screen displays 25 lines of 80 columns each, and is capable of generating 96 ASCII characters with upper- and lowercase letters.

The 630 terminals have a detached typewriter-style keyboard with 81 keys, including six function keys and an optional numeric keypad. For users who aren't comfortable without typewriter noise, there's an adjustable electronic keyclick generator. And there's also an end-of-line warning beeper. In addition, the keyboard has a TTY (teletype) lock for use in teletyping data.

Additional features of the 630 series include full editing abilities (including column tabs), a user-programmable in/out port, a horizontal split screen which you can also program, a switch-selectable interface for communicating like an expert with most popular computers, an interface to transmit data by line or page at rates ranging from 110 to 9,600 baud, and the ability to add two, four, or more pages of memory.

Another security-oriented TEC line is the Series 70, which offers the same basic features as the 630/630-C, plus limited graphics capabilities, including solid horizontal and vertical lines to create bar charts and graphs. Because of its extra graphics abilities, the TEC 70 has 87 keys on its detached keyboard—6 more keys than the 630 line—and 8 function keys, 2 more than the 630 gives you.

The Series 70, like the Model 630, can be ordered with an optional magnetic card reader. And it can be customized to meet other needs.

TEC, Inc.

TEKTRONIX 4006-1, 4012, AND 4014

You can't please everyone, but as far as Tektronix is concerned, it's not for lack of trying. Tektronix has a terminal for almost every conceivable kind of need, ranging from "plain-vanilla" units designed for simple text and data entry to ultrasophisticated models that can generate extremely high-resolution color graphics.

The basic terminal in the Tektronix line is the TEK 4006-1, a monochrome unit with both a graphics mode and a text mode showing a nice big 74-character by 35-line display. The 4006-1, designed for the demanding but cost-conscious customer, is ideal for use in classrooms, in stockrooms and at office workstations because of its sturdy attached keyboard. In its graphics mode, it will draw charts, tables, graphs and diagrams. Transmission rates run from 75 to 4.8K baud.

The Tektronix 4012 terminal is a step-up model that has a larger character set and is compatible with the DEC PDP-11 minicomputer. Take one more step up the Tektronix ladder and you'll find the TEK 4014, a model that is especially well-suited for the creation of maps and charts requiring special symbols. The TEK 4012 has 26K of local graphics memory that can be used to store symbols, overlays, or background graphics. An additional 32K of graphics memory is optionally available for users with even greater graphics needs. The TEK 4014 is a marvelous terminal for use in engineering, mapmaking, medicine, and other fields that make extensive use of standard graphics symbols. And, thanks to the terminal's built-in expandability, its capabilities can be increased easily as your needs grow.

Tektronix, Inc.

TEKTRONIX 4016-1, 4025A AND 4027A

The TEK 4016-1 is a high-resolution monochrome text-and-graphics terminal with a giant 25-inch screen. Because of its gargantuan video display—and its ultra-high-resolution graphics capabilities—the 4016-1 is a terrific terminal for designers of large, detailed charts and graphs. It can be used to design detailed electronic circuit boards, town and city utility networks, automotive diagrams, street maps, and even newspaper pages. The 4016-1 produces fine detail and sharp graphic lines, and a thumbwheel-controlled cursor makes it easy to create and change the display.

Along with the high-resolution graphics offered by the TEK 4016-1, you also get high-density alphanumeric text, which can be used either by itself or to label high-resolution charts, graphs, and

drawings. The terminal can display up to 15,000 characters at once on its monitor screen, in a choice of two formats: one page of 179 columns across the full width of the screen, or two 85-column pages displayed like an open book. And if you want to see bigger text rather than more text, you can have that, too. Three different sizes of large text can be displayed on the terminal's screen, the biggest of which can be easily used for group viewing.

The TEK 4025A and the TEK 4027A are similar to the TEK 4016-1, but the 4027A is a color terminal, with a capability of displaying up to eight colors simultaneously. The screen sizes of the terminals also differ; the 4025A has a 12-inch screen, and the 4027A has a 13-inch display. Both terminals have 16K of display memory, and the 4027A is also equipped with 48K of graphics memory, expandable to a huge 192K. With the 4025A, a 32K graphics memory is optional.

On both the 4025A and the 4027A, the screen can be divided into two separate viewing areas, each with independent scrolling. With this split-screen feature, you can display local and host transmissions in separate screen windows, or you can use the extra window as a workspace when you're creating a graphics display.

The 4025A and the 4027A are equipped with both pre-defined editing keys and user-definable editing keys. But on these terminals, the distinction between pre-defined and user-programmable keys is not carved in stone; nearly all the 81 keys on each terminal's keyboard can be redefined by the user to put a command into effect.

Tektronix, Inc.

TEKTRONIX 4105, 4107, 4109 AND 4112A

These most deluxe of Tektronix terminals are a marvel of graphics achievement. The terminals in this series combine DEC VT-100-style text editing with (in the TEK 4115B) a palette of up to 256 colors that may be used simultaneously. Some models also offer 3D-like video imagery and can "zoom in" on details of pictures that they have created. All of Tektronix's best high-resolution graphics terminals are supported by push-button color copiers, and many have local graphics processing modules.

The TEK 4105 is a 13-inch terminal with a detached keyboard and 82 programmable keys. When you use the 4105, you can "window in" on any part of the screen in order to increase detail. Up to 16 colors can be used at a time, including up to 8 colors of text, which can be displayed along with graphics on the screen. A joystick or mouse can be used to position the cursor on the screen, or to

draw lines or scroll text. The 4105 terminal can be used with software written for the TEK 4010 series; software written for 4105 is upward-compatible with both the 4100 series and the 4110 series.

TEK 4107 has all of the features of the Model 4105, plus a local memory of up to 128K. This increased memory allows graphics to be redrawn and manipulated as needed, and helps to increase operating speed. The TEK 4107 can display 16 colors simultaneously, from a palette of 64, and colors can be changed locally. Text can be displayed in 8 colors, along with graphics. Data transmission zips right along at rates of up to 38,200 baud, just as it does with the TEK 4107, the TEK 4105, and the TEK 4109.

The TEK 4109 has a big 19-inch screen and a local memory capacity of up to 256K. That's enough room for lots of pictures to be drawn, stored, and called back up—all locally, without any help from a host computer. If you're lucky enough to own a TEK 4109, you can use up to 16 screen colors at a time, choosing them from an enormous palette of 4,096 colors. Like the TEK 4107 and the other terminals in the TEK deluxe series, the 4109 has the ability to zoom in on details of pictures displayed on its screen. The zoomed-in picture is not just a fuzzy enlargement, either. On a TEK terminal, a zoom-in can significantly increase the detail and clarity of whatever section of a picture you want to see.

The TEK 4112A is a 15-inch terminal that offers most of the features of the TEK 4109, plus an extra feature called "two-dimensional transformation." This feature allows pictures not only to be zoomed out and in, but also to be rotated and otherwise moved around on the screen so that they can be viewed at different angles, all using simple keyboard commands.

The 4112A terminal has an attached keyboard with 72 keys, including 8 user-definable function keys. The terminal is compatible with TEK's 4010, 4100, and 4110 display terminals.

The TEK 4112A has 72K of local text memory, and 32K of graphics memory—expandable to a whopping 672K—for the local storage of pictures or picture segments such as schematic components, symbols, titles, and text. This capability increases the power of the terminal tremendously; when pictures and picture elements are stored in the terminal's memory, they can be redrawn without accessing the host.

Another state-of-the-art TEK terminal, the Model 4113A, is locally programmable, a feature that can be added easily to TEK's original 4113 terminal. The 4113A has 32K of RAM, expandable to a huge

800K, plus 88K of ROM. Three memory planes provide for the overlaying of text and graphics information, a useful feature when multilayer graphics are being prepared. And multiple viewports for text and graphics also allow you to see a variety of combinations on the screen at the same time. Eight colors may be displayed at one time, but with an option, you can get 17 colors on the screen simultaneously.

Another TEK terminal, the Model 4115B, is a designer's dream. With the TEK 4115B, you can display up to 256 colors from a palette of 16 million colors. A display controller redraws high-density mechanicals or gate arrays in less than a second. The terminal includes an Intel 8086 central processor, an Intel 8087 coprocessor, and a graphics processor for fast response time. Local memory stores up to 800K of information. Like TEK's other terminals, it is compatible with Plot 10 graphics software and the 4010, 4100 and 4110 series of terminals. An interface makes it compatible with DEC's Vax. Optional keyboards may be attached to type in Swedish, Danish/Norwegian, Japanese, or in British-style English, with pound symbols and so on. The TEK 4115B is plug-compatible with Tektronix 4691 Color Graphics copier. The unit is available either as a pedestal unit or in a desktop configuration.

The TEK 41156A is a color terminal with a giant-size 25-inch display making it well-suited for highly complex graphics requiring fine resolution. A thumbwheel cursor makes it easy for the user to work precisely with detailed sections of the screen. The display can be formatted for 179 letters across the screen, or as two 85-character pages, like an open book. Three large-character fonts are built in, the largest of which is suitable for group viewing. The 4116A comes as a pedestal or workstation with detached keyboard, including 8 user-definable keys. Memory size is 32K bytes RAM with optional additions up to 512K bytes, and 56K bytes ROM.

Tektronix, Inc.

TELEVIDEO TERMINALS

TeleVideo is one of the most respected names in the computer-terminal industry, and when you sit down at the keyboard of one of the company's systems, it's easy to see why. All TeleVideo terminals boast at least some of these highly desirable features: tilt-and-swivel screens; green-phosphor anti-glare screens with text displays of 24 lines by 80 or more columns; a screen-saving "attract mode" feature that turns off the display during inactive periods to enhance CRT longevity; sculptured keys on a detached keyboard with nonskid feet; and

programmable keys with a separate numeric keypad. Many of the company's models also have ANSI-standard communications capabilities to pass and receive information to and from a variety of other terminals. TeleVideo terminals are also equipped with foreign character sets for proper accenting.

The specific features you get in a TeleVideo terminal depend, of course, upon the model you choose. The TeleVideo 970, for example, features a tilt mechanism that requires just a touch to set the screen at exactly the right viewing angle for your comfort. The 970 looks quite smart, too; in fact, it's a unit that may really enhance your desk. The unit has a 14-inch green screen (measured diagonally) that displays 24 lines of text up to 132 columns wide in either standard or reverse video.

The 970's low-profile keyboard has a built-in palm rest, with dimensions engineered to minimize hand movement, a major source of fatigue. There's a separate keyboard-mounted keypad with numbers that can help you figure out your budget or do any other kind of calculator-style number juggling. And there's also a set of 32 function keys that enable the user to execute frequently used commands with a single keystroke. There are eight foreign character sets to choose from. For communication with the outside world—and for hard-copy printing, if you need it—two RS-232C buffered ports are standard. The unit is compatible with the DEC VT-100, and data transmission speeds range from 509 to 19,200 baud.

The TeleVideo 950 is a terminal that lets you design forms easily, with the help of its visual attributes and 15 special graphics characters. The 950 has 22 programmable function keys to execute repetitive commands or program-language control codes with a single keystroke. Split screen with line lock saves time and reduces error entry by guarding against the inadvertent transmission of local reference material or instructions while on-line. Creation of good-looking forms and displays is also a feature of the 925, with 5 visual attributes, selectable in 15 different applications.

The TeleVideo 924 is equipped with a host of special features, including four pages of local memory, a field-protection system to prevent deletion of important information, and an accounting-style numeric keypad with a "00" key and an extra-large "0" key to speed numeric entries. A programmable keyclick helps verify data entry, and there are 32 non-volatile, user-programmable function keys.

The TeleVideo 924 also has a number of sophisticated graphics features, including 32 special

graphics characters and double-height characters that can be used for titles, headlines, and form design. An optional feature of the 924 is a special microchip that lets the terminal emulate TeleVideo's 950 and 925.

The TeleVideo 915 comes with 32 pre-programmed function keys and an "autoflip" function that allows you to flip between pages displayed on the screen and pages stored in local memory. There are two RS-232C ports, and data transmission rates range from 150 baud to 19.2 kbaud. The 915 emulates the popular ADDS Viewpoint, and it's easy to reconfigure the terminal from the keyboard or host computer to emulate other monitors. With an optional chip, the 915 can emulate TeleVideo's 910 Plus (described below).

TeleVideo's Model 914 has a very special feature: a set of 64 special graphics characters. Other features of the TeleVideo 914 include 32 possible combinations of visual attributes for customizing forms and displays, 6 programmable function keys, 2 RS-232 ports for peripherals and communications, and emulation of the ADDS Viewpoint terminal. The 914 can also be configured from the keyboard or from the host computer to interact with other kinds of terminals.

The TeleVideo 910 Plus is a one-piece terminal, an integrated unit including both keyboard and CRT in a single package. The 910 also has a number of special video features, including blinking, reverse video, and half-tone graphics. Keyboard features include 10 preprogrammed function keys, bi-directional tabbing to facilitate formatting, and a separate keypad. The Model 910 can emulate a number of the most common terminals, such as Hazeltine 1410, the ADDS 25, and the Lear Siegler ADM-3A/5.

TeleVideo Systems, Inc.

TELEVIDEO PERSONAL TERMINAL

The TeleVideo Personal Terminal is worthy of special note for several reasons—including both its low price (under \$500) and its small size (12½ inches wide, 15 inches deep and 9½ inches high). According to TeleVideo, the Personal Terminal was designed for managers who need to access data and reports but who don't want a terminal taking up half of the top of a desk. The Personal Terminal is perfect for these users. Its desktop footprint is smaller than that of an average typewriter and not much bigger than that of a typical in-box. Yet the unit has a full-size, typewriter-style keyboard and a respectable 9-inch light-green phosphor screen

that can display a full 24 lines of text or data, in either 40-column or 80-column lines.

The Personal Terminal can be purchased with an optional modem and an optional snap-on telephone receiver. So when you aren't using it for terminal-to-computer or terminal-to-terminal communications, you can use it as a conventional telephone!

You can display standard and reverse video on the Personal Terminal's screen, and you can create reports that pack a punch by intermixing text and graphics characters. There are 128 different graphics characters to choose from, and you can use them to design charts, graphs, and many other types of business graphics.

The Personal Terminal has 7 programmable function keys that can be used in tandem with a shift key for a total of 14 functions. Labels describing the functions of each key can be placed on the screen to remind you of what you've programmed each key to do.

The TeleVideo Personal Terminal is equipped with two standard RS-232 ports, each of which can be connected to either a telephone modem or a serial printer. And the terminal can be used with either a 300-baud or a 1,200-baud modem for telephone connection to computers, databases, and other terminals. Up to 28 telephone numbers can be stored in the terminal's memory and dialed automatically on command. And you can program the unit's function keys for true one-stroke automatic dialing.

TeleVideo Systems, Inc.

TTX

Teletex Communications Corp. now manufactures two computer terminals that are especially well-suited for use in word processing. The company's original and still popular smart terminal, the TTX 3000, has a detached keyboard, a 12-inch screen, and 10 user-programmable function keys. And now there's a newer model, dubbed the TTX 3003 Smarter Terminal, which is similar to the 3000 but is equipped with 19 user-programmable keys and two pages of local memory.

Both Teletex terminals are microprocessor-based, and they're pretty smart, too; both models can easily expand into stand-alone computers with the addition of one or two floppy- or hard-disk drives. And a spacious base housing provides room for the drives, as well as for the installation of a CPU card.

Both TTX models are compatible with the Televi-

deo 910 terminal. The communications speeds of the 3000 and the 3003 range from 50 to 19.2 kbaud, and words may be sent character-by-character, line-by-line, or in page or block mode.

Both the TTX 3000 and 3003 have built-in graphics capabilities, and the 12-inch monitor that comes with both units can display characters in either standard or reverse video. Each unit is designed to be connected to its keyboard with a four-foot cord. And both keyboards have an electronic key-click mechanism that you activate if you want to hear typing sounds.

Teletex, \$599

VISUAL

Name-brand emulation at budget prices: if that's what you're looking for, then one line of terminals you'll surely want to check out is manufactured by Visual Technology, Inc., of Tewksbury, Massachusetts. Visual terminals are not only compatible with most of the popular name-brand units on the market; they also offer many special features of their own.

The Visual 500 and 550, for example, emulate Tektronix 4010/4014 terminals but cost only about half as much. And both units are equipped with a host of useful graphics functions and also a big, easy-to-read display.

The Model 500 and 550 are compatible with standard business, laboratory, and scientific software, such as the Tektronix Plot 10 graphics program. Advanced graphics capabilities of the Visual units allow the user to draw arcs, rectangles, many different kinds of lines, and shape fills. The video monitor that comes with the 500 and the 550 is a large 14-inch unit with a sharp resolution of 768 by 585 pixels and a sharp, clear 80-column by 33-line display.

The Model 500 provides emulation of the DEC VT-52, the Data General D200, the Lear Siegler ADM-3A, and the Hazeltine 1500. The Visual 550 complies to the ANSI X3.64 standard and is DEC VT-100 protocol-compatible. Both models emulate the Tektronix 4010/4014.

Still another Visual unit, the Model 383, emulates the Burroughs TD830. The Visual 383 display tilts 10 degrees forward and 15 degrees back, and swivels 270 degrees. The terminal has eight programmable function keys, for a total of 16 functions, and it includes six pages of local memory, local forms storage, and password protection.

The Visual 300 and 330, like the 500 and 550, are microprocessor-controlled. The 300 complies to

the ANSI X3.64 standard for display terminals and is protocol-compatible with DEC VT-100/VT-52 terminals. The unit has an eight-page (192-line) storage unit for word processing. The 330 is similar, except that it emulates the DEC VT-52, the Lear Siegler ADM-3A, the Hazeltine 1100, and the Data General D200.

The Model 300 and the Model 330 can be ordered with a green or black-and-white tilt-and-swivel monitor that measures either 12 or 14 inches diagonally. Each terminal has 12 non-volatile, user-programmable function keys capable of storing a total of 32 codes. Other features of the Visual 300 and 330 include line-drawing characters, split-screen feature, editing functions, and programmable tabbing.

Visual says that its Model 102 offers all of the performance features of the DEC VT-100 and VT-102. With an optional graphics card, the 102 can also emulate the Tektronix 4010/4014, with a resolution of 768 by 293 pixels.

Visual's low-end terminals, the Model 50 and the Model 55, also offer some unusual features for units in their class. The Model 50 has three programmable function keys, for example, and the Model 55 has 12. Other features of the Visual 55 include scrolling windows, split-screen capability, and text-editing functions. Both the Visual 50 and the Visual 55 are encased in a lightweight ergonomic plastic enclosure, with monitors that can be tilted and swivelled.

The Visual 50 and 55 are compatible with the Hazeltine Esprit, the ADDS Viewpoint, the Lear Siegler ADM-3A, and the DEC VT-52. The Model 55 adds emulations of Hazeltine 1500/1510 and Visual 200/210.

All Visual terminals have detachable keyboards, and standard RS-232 interfaces that allow them to communicate with host computers, printers, and modems. Communications on all models can reach speeds of 19.2 kbaud.

Visual Technology, 500 \$2,495; 550 \$2,645; 383 \$1,495; 300 \$995; 330 \$995; 102 \$1,095; 50 \$695; 55 \$895

WYSE

It's a terrible pun, but that doesn't make it any less true; Wyse products are wise choices for the computer-terminal buyer. They're aesthetically pleasing, they're ruggedly built, and they have a multitude of features that will allow you to work faster and more easily.

The WY-50 and WY-75 terminals are sleek, beau-

tiful electronic machines. Each comes with a big 14-inch video monitor that can display up to 132 columns of text, yet takes up less than a square foot of desk space.

The Model WY-50 is compatible with many popular terminals, including the WY-100 (Wyse's original terminal) and the Lear Siegler ADM-31. The WY-150 can also emulate the TeleVideo 910, the ADDS Viewpoint, and the Hazeltine 1500. The WY-75 is compatible with the growing number of terminals that use the ANSI X3.64 standard for communicating among terminals and computers.

Both terminals can communicate at speeds ranging up to 19,200 baud. Both also enable the user to enter terminal parameters, such as transmission speeds, directly from the keyboard.

One special feature of the WY-50 terminal is that it can be expanded into a MS-DOS (IBM PC-compatible) microcomputer quite easily with the addition of a 16-bit 80186 microprocessor and a set of peripherals that are available as a kit. The kit includes the 80186 chip, two 5¼-inch floppy disk drives, 128K of RAM, and even a 512K plug-in memory card. The upgrade package also includes the MS-DOS operating system that lets you run the popular MS-DOS software.

Whether you use the WY-50 as a terminal or upgrade it into a computer, you get the famous Wyse tilt-and-swivel video monitor and a detached keyboard with two positions: one inclined like a typewriter, the other flat. There are 101 keys on the board, with full numeric keypad, a set of cursor control keys, and 16 programmable function keys.

Another popular Wyse terminal is the WY-200, which can run computer programs locally and can generate multiple split screens. Other features of the WY-200 include smooth scrolling, forms generation, and a 132-column text-display mode.

Still another popular Wyse product is the WY-300 color CRT, a video monitor that is completely compatible with the systems currently using the WY-100 terminal. Wyse also supplies *WyseWord*, a software program that lets you use the *WordStar* word-processing program with a reduced number of keystrokes on Wyse terminals.

Wyse Technology, WY-50 \$695; WY-75 \$795; upgrade kit \$2,695

ZENITH ZT-1, ZT-1A, ZT-10, ZT-11

In all its variations, the ZT-1 is a full-featured communications terminal. It comes with a built-in program that includes auto-dial and auto-log-on, including password protection, so that once you've entered your password no one else can get it out

again. The memory will store 26 phone numbers. It is guarded against accidental erasure by a battery backup. As with similar systems, this program contains carefully designed, self-explanatory menus that minimize the need for additional help.

The differences between the models lie in their intended use. The ZT-1 is customized for use with CompuServe. It lets you enter the phone number and the entire log-on sequence for this system and will call and log-on for you with a single keystroke. The ZT-1A is similarly customized for THE SOURCE. With either version, when dealing with any other utility, the terminal cannot include your password as part of the log-on sequence. Each terminal expects to follow certain steps with either CompuServe or THE SOURCE, and neither can be instructed to follow any other procedure.

The ZT-10 and ZT-11 are not customized for any utility, but their built-in program lets you give them detailed instructions for each log-on sequence. This makes for a little extra work in entering your log-on sequences into the terminal, but it also makes for more flexibility in what the terminal can do. The result is that the ZT-10 or ZT-11 will let you enter the entire log-on sequence for each entry, including your password.

This alone makes the ZT-10 or ZT-11 the more attractive variations on this model, but there is another advantage as well. The ZT-10 and ZT-11 have an RS-232 port, the ZT-1 and ZT-1A do not. This means that with the ZT-1 and ZT-1A, you are limited to using the internal 300-baud modem. With the ZT-10 or ZT-11, you can attach an external 1200-baud modem to the RS-232 port. Not only that, but you can also still take full advantage of the terminal's auto-dial and auto-log-on features. With the ZT-10, you must use an external modem in any case, since this model has no built-in modem.

The built-in modem on the ZT-1, ZT-1A and ZT-11 is a 300-baud, 103-compatible unit with four operating modes: originate, answer, auto-answer, and auto-dial. Unfortunately, dialing is by pulse only; you cannot call through any of the long-distance carriers that require tone dialing. Here again, the ZT-10 and ZT-11 give you the option of using an external modem that allows tone dialing.

The ZT-1 series terminals come with free registration for and one free hour on Dow Jones/News Retrieval, THE SOURCE, and CompuServe. They also come with a six-month trial membership in Comp*u*Store, a discount shopping service.

Zenith Data Systems, ZT-1 or ZT-1A, with monitor \$569, without \$449; ZT-10, with monitor \$499, without \$399; ZT-11, with monitor \$579, without \$479

TERMINALS

Manufacturer	Model	Keys	Monitor Type	Screen Size (inches)	Character Resolution	Local Memory	Max. Baud Rate	Compatibility *	Price
ADDs	Viewpoint 90	89	Mono†	12	7x8	2K	19.2	ADDs Regent, Viewpoint series	\$1195
	Viewpoint 60	78	Mono	12	7x8		19.2	ADDs Regent 40, 60	\$895
	Viewpoint Color	78	Color	13	5x8		19.2	Viewpoint 60; ADDs Regent 40, 60	\$1295
	Viewpoint 78	85	Mono	13	5x8		19.2	IBM 3271 controller; IBM 3278 terminal	\$1095
	Viewpoint 78 Color	85	Color	13	5x8		19.2	Same as above	\$1995
	Viewpoint 3A	96	Mono	12	5x7		19.2	LS ADM 3A, 5; Tel. 912, 920; Soroc IQ-120	\$650
	Viewpoint A1	96	Mono	12	5x7		19.2		\$650
	Viewpoint A2	96	Mono	12	5x7		19.2		\$650
Ampex	D125		Mono	12	6x10	1 page	19.2	ADDs Regent 20, 25, Viewpoint; DEC VT 52; Haz. 1500, 1400, 1410, 1420; LS ADM 3A, 3A+, 5; Soroc IQ-120, 120C; Tel. 910, 910+, 912, 920	\$679
	D150		Mono	12	6x10	2 pages	19.2	Same as above, plus Tel. 925, 950	\$849
	D175		Mono	12	6x10	2 pages	19.2	Same as above, plus IBM Selectric keyboard	\$869
Beehive	ATL-008	94	Mono	14	7x9	32 to 128K	19.2	DEC VT 100/ANSI 3.64 codes; RS 232, 422	\$1495
	ATL-004	94	Mono	14	7x9	10K	19.2	DEC VT 100	\$995
CTi Data Corporation	CTi 1000A		Mono	12				RS 232; IBM 2740, 3767	\$2595
Digital Equipment Corporation	VT 220	103	Mono	12				VT 100	\$1295
	VT 240	103	Mono	12				VT 100; DEC Regis; Tektronix 4010, 4014	\$2195
	VT 241	103	Color	13				VT 100; DecGraph	\$3195
Hazeltine	Executive 10/102G	83	Mono	14	4096x321 ¹ ; 1024x780 ¹ ; 5x9	Graphics memory	19.2	DEC VT 100, 101, 102, 131; RS 232; TEK 4010, 4014	\$1595
	Executive 10		Mono	12	7x10		19.2	Haz. 1500; RS 232	\$1195

TERMINALS (Continued)

Manufacturer	Model	Keys	Monitor Type	Screen Size (inches)	Character Resolution	Local Memory	Max. Baud Rate	Compatibility*	Price
	Esprit III		Mono	13	7x11	Opt. 48, 72, or 96 lines; PROM	19.2	TVI 950	\$895
	Esprit II		Mono	12	7x11		19.2	ADDS Regent 25; LS ADM 3A	\$645
	Esprit Executive 10/78		Mono	12	7x10		19.2	IBM 3278	\$1095
	Esprit Executive 10/51		Mono	12	7x10		19.2	IBM 5251 for System 34 or 38	\$1150
	Esprit Executive 10/25		Mono	14	7x10		19.2		\$1045
	Esprit ESP		Mono	14	7x11	Optional 4 pages	19.2	Tel. 925, 910 + ; ADDS Regent 25, Viewpoint; Haz. Esprit II, 1500; LS ADM 3A	\$695
	Esprit		Mono	12	7x11		9.6	Haz. 1500; ADDS Regent 25; LS ADM 3A	\$595
Heathkit	H/Z-29	77	Mono	12	8x10		19.2	ANSI protocol terminals; Heathkit H/Z-19; LS ADM 3A; Haz. 1500A; DEC VT 52, 100	\$599
	Personal Info. Terminal HT-10	63	Mono	12		26 phone numbers	9.6		\$449
Human Designed Systems	Concept AVT +	101	Mono	12	7x11	4 pages, expandable to 8		ANSI X3.64; DEC software; DEC VT 100, 52	\$1295
	Concept AVT-APL	102	Mono	12	7x11	Same as AVT +	9.6	VT 100	\$1495
	Concept GVT	102	Mono	12	6x6 250x512 ¹	1 page graphics; text same as above	9.6	Tektronix 4010	\$1895
Kimtron	KT-7		Mono	12	7x9	1 page std.; up to 4 pages opt.	19.2	Tel. 910, 920, 950; DEC VT 52, 100, 132; DG 100, 200; IBM PC; TEK Plot 10 graphics	\$595
Lear Siegler	ADM 11	QWERTY	Mono	12 std. 14 opt.	7x10	256-character buffer	19.2	All ASCII terminals	\$695
	ADM 12	QWERTY	Mono	12 std. 14 opt.	7x10	2 pages; 256-character buffer	19.2	All ASCII terminals	\$895
	ADM 24E	Selectric	Mono	12 std. 14 opt.	7x11	2 pages std.; 2 more optional	19.2	All ASCII terminals	\$1250
	ADM 3A	59	Mono	12	5x7	19.2 with RS 232	9.6	All ASCII terminals	\$695
	ADM 5	83	Mono	12	5x9	19.2 with RS 232	9.6	All ASCII terminals	\$745

TERMINALS (Continued)

Manufacturer	Model	Keys	Monitor Type	Screen Size (inches)	Character Resolution	Local Memory	Max. Baud Rate	Compatibility *	Price
Liberty	Freedom 100	100	Mono	12	7x9		19.2	Tel. 910; ADDS Regent 25; Haz. 1420; LS ADM 3A, ADM 5	\$495
	Freedom 200	106	Mono	12	7x9	1 page; 2 in emulation mode	19.2	Tel. 950; LS ADM 31; Freedom 100	\$795
Link	Smart Link 150		Mono	12		4 pages opt.	19.2	Tel. 950	
Micro Display Systems	Genius 202		Mono	15			19.2	IBM PC	\$1995
	Genius 212		Mono	15	800x720 ¹		19.2	DEC VT 100	\$1995
Micro Term	ERGO 201		Mono	12	7x11	2 pages opt.	19.2	Tel. 925; LS ADM 3A; DEC VT 52; Micro-Term ACT 5A; others with customization	\$795
	MIME-2A	Attached	Mono		7x11	1 page std.	19.2	DEC VT 52; Haz. 1500; Soroc IQ 120	\$1045
	ACT-5A	Attached	Mono			1 page std.	19.2		\$995
	ERGO 301		Mono		7x11	2 pages; 256-character buffer	19.2	DEC VT 100; TEK Plot 10 (with addition)	\$895
	ERGO 4000		Mono	15	5x8	1 page std.	19.2	ANSI X3.64; DEC VT 52, 100	\$1195
QUME	QVT-211 GX		Mono	14	644x288 ¹ 7x9	For graphics only	19.2	Haz. 1500; LS ADM 3A, 5; Tel. 910	\$1295
	QVT-108		Mono	12 std. 14 opt.	7x9	2 pages std.	19.2	Tel. 925, 920, 912	\$895
	QVT-103		Mono	14	7x9	Above; more opt.		DEC VT 100, 131	\$1095
	QVT-102		Mono	12	7x9	Same as above	19.2	Same as QVT-211 GX	\$695
Quazon	Quick-Link 300	61	Mono (TV)	Varies			300		\$250
Sanyo	CRX 1100	100	Mono	12	6x9; 6x11 (lowercase)	8K ROM; 6K RAM	19.2	Built-in emulator; RS 232	\$695
Soroc	Challenger 530		Mono				38.4		\$695
	Challenger 540		Mono		5x9		38.4		\$995
	Challenger 550		Mono	12	5x9		38.4	LS ADM 1, 2; Tandem 6510	\$1395
	Challenger 525	Selectric	Mono			96 bytes		Tel. 925	\$895

TERMINALS (Continued)

Manufacturer	Model	Keys	Monitor Type	Screen Size (inches)	Character Resolution	Local Memory	Max. Baud Rate	Compatibility *	Price
	C 540/AM	Selectric	Mono			96 bytes	38.4	Alpha Micro AM-60; Alpha software	\$895
	C 540/B4	Selectric	Mono			96 bytes	38.4	Basic 4, 7270	\$895
Tandy	Radio Shack	70	Mono			for configurations	19.2	Tel. 910; LS ADM 5; ADDS 25; Haz. 1410	\$699
TEC	ET 80		Mono	15		5 pages	19.2	DEC VT series; ASCII plus ANSI X3.64	\$1370
Tektronix	4006-1		Mono	7.5x5.6			4.8		\$3900
	4012			8x6				DEC PDP-11; D6 NOOA, HP2100 series interface	\$6200
	4014			19		26K graphics; 32K more opt.		Same as above	\$15,750
	4016-1		Mono	25			9.6	TEK 4014-1 software; TEK Plot 10	\$20,500
	4025-A	81		12		16K; 32K optional	9.6		\$5900
	4105		Mono	13	480x360 ¹ 5x9		38.4	IBM SNA 4970 controller; TEK 4010, 4100, 4110	\$3995
	4107		Mono	13	640x480 ¹ ; 7x9	Up to 128K	38.4	Same as above	\$6950
	4109		Color	19	640x480 ¹ ; 7x9	Up to 256K	38.4	Same as above	\$9950
	4112A	72		15	640x480 ¹	72K text; 32K graphics; expandable to 672K	9.6	TEK 4010, 4100, 4110	\$6500
	4113A	72	Color	19	640x480 ¹	32K expandable to 800K; 88K ROM	9.6	TEK Plot 10	\$14,000
	4115B		Color				19.2	Above, plus TEK Plot 10 graphics; DEC Vax	\$22,950
	4116A	72	Color	25		32K expandable to 512K; 56K ROM	19.2	TEK 4010, 4100, 4110; TEK Plot 10	\$22,400
Televideo	Televideo 970		Mono	14	6x8	Additions opt.	19.2	DEC VT 100; ANSI X3.64	\$1495
	Televideo 950		Mono					Same as above	\$1195
	Televideo 924		Mono			4 pages		Tel. 950, 925	\$899
	Televideo 914		Mono	12	7x8		19.2		\$699

TERMINALS (Continued)

Manufacturer	Model	Keys	Monitor Type	Screen Size (inches)	Character Resolution	Local Memory	Max. Baud Rate	Compatibility*	Price
	Televideo 910 Plus		Mono					Haz. 1410; ADDS 25; LS ADM 3A, 5	\$699
	Personal Terminal		Mono	9	5x7	Enough for 28 phone numbers	19.2		\$499
TTX	TTX 3000	95	Mono	12	5x7		19.2	Tel. 910	\$599
Verticom	PLP 100/200	105	Color	13	640x480	320K; 2K CMOS RAM; 2 pages graphics memory		DEC VT 100; TEK 4010; units using NAPLPS†	\$5650 ² \$6450
Visual	Visual 500		Mono	14	768x585 ¹ 7x11	256-byte buffer	19.2	TEK 4010, 4014, Plot 10; DEC VT 52; DG D-200; LS ADM 3A; Haz. 1500	\$2495
	Visual 550		Mono	14	768x585 ¹ 7x11	256-byte buffer	19.2	TEK 4010, 4014; ANSI X3.64; DEC VT 100	\$2695
	Visual 383		Mono	14	7x9	6 pages	19.2	Burroughs TD-830	\$1495
	Visual 300		Mono	12 or 14	7x9	8 pages	19.2	ANSI X3.64; DEC VT 100, 52; teletype	\$995
	Visual 330		Mono	12 or 14	7x9		19.2	DEC VT 52; LS ADM 3A; Haz. 1500; DG D-200	\$995
	Visual 102		Mono	14	768x293 ¹ 7x9		19.2	DEC VT 100, 102; TEK 4010, 4014	\$1095
	Visual 50		Mono	12	7x9		19.2	Haz. Esprit; ADDS Viewpoint; LS ADM 3A; DEC VT 52	\$695
	Visual 55		Mono	12	7x9		19.2	Above + Haz. 1500, 1510; Visual 200, 210	\$895
WYSE	WY-50	101	Mono	14	7x13		19.2	WYSE WY-100; LS ADM 3A; Tel. 910; ADDS Viewpoint; Haz. 1500; MS/DOS (IBM PC)	\$695
	WY-75	101	Mono	14	7x13		19.2	ANSI X3.64	\$795
ZENITH	Z-29	91	Mono	12	5x7; 5x9 (lowercase)		19.2	ANSI protocols; DEC VT 52, 100; LS ADM 3A; Haz. 1500	\$849
	ZT-1	63	Mono	12	5x9	26 phone numbers	4.8	DEC VT 52	\$449 ³ \$549
	Z-49	92	Mono	14		For setup	19.2	DEC VT 52, 100; ANSI X3.64; DEC VAX, PDP	\$1099

* Abbreviations used: DG: Data General; DEC: Digital Equipment Corporation; Haz.: Hazeltine; LS: Lear Siegler; Tel.: Televideo.

† Mono: monochrome. ‡ NAPLPS: North American presentation-

level protocol syntax. ¹ Resolution in graphics mode. ² First price for Model 100; second for Model 200. ³ First price without monitor; second price with monitor.

MONITORS

Of the hundreds of kinds of computer peripherals on the market, there's only one that you simply cannot do without: a video monitor. A computer without a monitor is like a typewriter without paper, an easel without a canvas, or an arcade game without a video screen.

Connecting a computer to a monitor is like rolling a sheet of paper into a typewriter, putting a canvas on your easel, or hooking a video game up to a TV screen. Without a monitor, you can't see what you're doing or what your computer is doing. With a monitor, you can.

Since a monitor is such an important part of a personal-computer system, it's a good idea to make sure that you'll have some kind of video display unit before you buy a computer and take it home. In some cases, an ordinary television set will work just fine. But if you're a real computer buff, or a business person with serious work to get done, you'll soon want a specifically designed computer monitor.

WHAT'S THE DIFFERENCE?

The principal difference between a television receiver and a computer monitor is that an ordinary TV set is designed to pick up TV broadcasts, while a monitor is designed to be connected directly to the source of a video signal—either a computer or some sort of video device such as a videocassette recorder, a video camera, or a videodisc machine.

Since a television set is built to pick up TV broadcasts, it has to have more electronic components under its hood than a video monitor has. One important component that you can find in a TV set but not in a monitor is a TV tuner.

A tuner, as its name implies, is a component that tunes in TV channels. A tuner can also be used to switch reception from one channel to another, and to fine-tune broadcast signals so that they can be received properly.

Since computer monitors are not designed to pick up TV broadcasts, they are not generally equipped with demodulators or TV tuners. The electronic signal produced by the video output of a personal computer is an unmodulated signal—the same kind of signal that's produced in a TV studio before it's modulated and transmitted. And, when a piece of equipment puts out an unmodulated signal, there's no need for the video display unit being used with it to be equipped with a demodulator.

A TRICKY QUESTION

If you've ever played with a moderately priced home computer, such as an Atari computer or a Commodore 64, a certain troublesome question

may have occurred to you: Isn't it true that some computers are designed to be used with standard television sets rather than with special monitors?

Good question.

The answer is that many kinds of moderately priced computers such as the Coleco Adam, the Atari family of computers, Radio Shack's Color computers, and the Commodore 64 are constructed so that they can be used either with standard television sets or with real video monitors. And that's good, since it means that the owners of these computers can either plug their machines into their family TV sets or invest in a real monitor.

For a computer to be compatible with both a TV set and a monitor, it has to be equipped with an electronic device called an RF (radio frequency) modulator. An RF modulator does just the opposite of what an RF demodulator does; it combines a video signal with a VHF signal so that it can be fed into the antenna terminal of a TV set and reproduced over a TV channel (usually channel 3 or 4) just as though it were being broadcast by a television station.

When a video signal is modulated and fed into a TV set this way, it must be demodulated by the TV set's tuner before it can produce an image on the TV set's screen. And that is exactly what happens when a modulated home computer signal is fed into a TV set through the set's antenna terminal. It is separated from its "carrier" wave and turned back into a straight video signal.

That sounds like a pretty roundabout way of getting a video display out of a computer—and indeed it is. But the technique achieves its purpose; thanks to this silly process, people who buy inexpensive home computers can connect them to their family TV sets if they like, and thus don't have to face the extra expense of purchasing a computer monitor.

But what happens if the owner of one of these computers wants to use a monitor rather than a TV set as a video display device? Usually that's quite easy to arrange. Most of the popular home computers now on the market are equipped with straight video outputs as well as outputs that produce modulated signals. They can therefore be used either with standard TV sets or with video monitors.

There are also some computers, such as the Apple IIe, which are designed to be used with monitors but can also be connected to standard TV receivers, if optional RF modulators are purchased and installed.

MONITOR OR RECEIVER?

If you need a video output device for a computer

and can't decide between a TV set and a video monitor, a monitor is probably a better choice by far, for several reasons.

One reason is that standard television sets are subject to many kinds of interference, while monitors aren't. In addition, signal degradation can take place during the process of modulating a signal, feeding it into a TV set, and then demodulating it so that it can be used. Sometimes the effect of this process is not too noticeable, but at other times it can be extremely annoying.

Another reason for picking a monitor over a TV set is that monitors usually—not always, but usually—have better performance specifications than standard receivers do, and are better equipped to handle the kinds of jobs that computer monitors must do.

A third reason for choosing a monitor is to avoid family squabbles over who has access to the family TV. If you want to operate your computer while someone else's favorite program is on the air, you can imagine the kinds of problems that might arise.

MONOCHROME OR COLOR?

Once you've decided whether you'll need a real monitor or whether a plain TV set will do, you'll have to make another important decision: Will you need a color monitor, or one with a monochrome display?

If you own a color computer and want to be able to display the software in all its glory, then it's obvious that you'll need a color monitor. But if you're more interested in using your computer for business applications such as filing, financial record-keeping, and word processing, then you might want to choose a monitor that produces an eye-saving, if less spectacular-looking monochrome display. Here it helps to know in advance what software you'll be using. Several popular business programs of the IBM Personal Computer and its relatives make extensive use of color.

RESOLUTION

Whether you pick a monochrome monitor or a color model, you'll have to decide whether you need a high-resolution or medium-resolution model. Medium-resolution monitors are usually defined as units with resolution specifications close to those of a standard television set. With a medium-resolution monitor (or high-quality television set, for that matter), you can usually get a clear display of 30 to 40 text characters across the width of your screen. If you want to display more than

that, the characters will start getting smaller—and if the resolution of your monitor isn't what it should be, they'll start getting blurry, too. If the resolution of the display you want exceeds the capabilities of your monitor by too much, the text on your screen will become downright unreadable.

With a high-resolution monitor, you won't have those problems. A high-resolution monitor can usually display 80 characters across a screen quite easily and is therefore usually a better choice for use with computers that are capable of generating 80-column text displays.

Most monochrome computer monitors are high-resolution models, but most color monitors are not. To get high resolution in a color monitor, you have to buy a unit that is especially designed to produce a high-resolution display.

There are two main varieties of color monitors: composite monitors and RGB (red-blue-green) monitors. Most (but not all) composite monitors are medium-resolution models, and most (but not all) RGB units are high-resolution monitors.

Most composite monitors generate screen displays that measure 32 to 40 typed characters wide. Most RGB monitors can display text lines that are 80 characters (or columns) wide, or more.

HOW THEY WORK

An RGB monitor is a special kind of high-resolution color monitor with a multipin input called a TTL (transistor-to-transistor logic) input. A TTL input provides a monitor with separate red, green, and blue video signals. Since these colors are not mixed together when they read an RGB monitor, they do not have to be separated inside the monitor, and their clarity and accuracy are not as likely to be diluted or contaminated as they would be if the colors were mixed together.

A composite monitor usually receives its red, blue and green signals through a single input—called, logically enough, a composite input. Most composite inputs are designed to accept video cables with RCA-type connectors, the type of connectors that are standard on monochrome monitors and on most kinds of home video components. However, some premium-quality composite monitors have professional-type inputs with studio-style BNC connectors.

RGB units are usually (but not always) more expensive than color monitors—and, since they are not ordinarily equipped with standard composite inputs, they must be used with computers that have special RGB outputs. Some microcomputers have built-in RGB outputs, and others such as those in

the Apple II/II+ /Ile series can be equipped to handle RGB signals with the addition of plug-in interface cards.

Plug-in cards that can be used to add RGB monitors to non-RGB computers are available from a number of companies, including Taxan, Princeton Graphic Systems, and Advanced Logic Systems of Sunnyvale, CA.

MONOCHROME MONITORS

Monochrome monitors are much less expensive than color models; they usually range in price from less than \$100 to around \$300. The screen displays of monochrome monitors come in various colors, including green on black, amber on black, and white on black. Black-on-white monitors are also available.

High-resolution monochrome monitors can't generate stunning color graphics as RGB monitors can. But if you plan to sit at your computer screen for hours on end, doing close-up work like programming or word processing, you'll probably find that a high-resolution monochrome monitor will be much easier on your eyes than the blazing colors of an RGB model.

Until fairly recently, green-screen monitors were considered the easiest kind to look at during long sessions at the keyboard—and therefore best for extended use in jobs such as data entry and word processing. Recently, however, many experts in ergonomics have been saying that amber monitors are even easier to look at and therefore even better than green-screen models.

SPECIFICATIONS

As you probably know, all TV sets and video monitors produce screen images made up of tiny dots called picture elements or *pixels*. These dots extend across the screen to form fine lines.

The resolution of a TV receiver or video monitor is measured by the number of dots that it can display horizontally, and the number of dots (or lines) that it can reproduce vertically, on its screen. The resolution specifications of video monitors can vary from less than 250 dots horizontally by 300 lines vertically to more than 1,000 dots by 1,000 lines.

The dots on the screen of a color monitor are created by electron beams fired through holes etched in a metal mask just behind the monitor's screen. The smaller and closer together these holes are, the higher the resolution of the monitor will be, and the finer the dots displayed on its screen.

The distance between the holes on a video tube's shadow mask is measured using a specification called *dot pitch*—and the smaller a dot-pitch spec is, the better. The dot pitch of color monitor screens usually ranges from as fine as 0.31 mm or so (which translates out to about 80 dots to the inch) to as coarse as 0.43 mm or more.

The *deflection angle* of a video tube is often listed in its specifications. The deflection angle is the angle at which a monitor's electron beam strikes its screen right in the middle. The deflection angle most often encountered is the best one: 90 degrees.

The video tubes in color monitors are also sometimes described as *in-line* tubes. An in-line tube produces red, green, and blue dots that are all lined up next to each other in a horizontal row across the screen. In-line guns are popular and produce excellent images, but some manufacturers of other types of guns—such as the triangular-pattern Delta gun offered by Mitsubishi—say their formats are better.

Other important monitor specifications include *video bandwidth* and horizontal and vertical *scanning frequencies*—sometimes also referred to as *sweep frequencies*.

Video bandwidth, measured in megahertz (MHz), is the rate at which a computer accepts data from a computer (or other video component). The faster this information is received, the faster and more sharply it can be displayed on a screen. Video bandwidths ordinarily range from about 4.5 MHz for TV sets and medium-resolution monitors to more than 50 MHz for some ultrahigh-resolution color monitors.

The horizontal scanning frequency of a monitor, measured in kilohertz (kHz), is the rate at which its electron beam returns to its starting position on the extreme left side of the screen after being deflected to the right for one left-to-right sweep. Horizontal scanning frequencies generally range from around 15.5 kHz to more than 24 kHz. A fast scanning rate can help make a video image clear and flicker-free—so generally speaking, the higher a monitor's horizontal scanning rate is, the better.

The vertical scanning frequency of a monitor, measured in Hertz (Hz), is the rate at which the electron beam returns to its starting position at the top of the screen after one scanning cycle down the screen. Most microcomputers sold in this country are designed to be used with monitors that have a vertical scanning rate of 60 Hz.

A notable exception to this norm is the IBM Personal Computer, which, for some reason, is designed to work with 60-Hz color monitors but with

50-Hz monochrome monitors. That means, of course, that if you ever have to buy a monochrome monitor for an IBM PC, you'll have to be very careful. A color monitor with a standard 60-Hz vertical scanning frequency will work just fine with an IBM PC (as long as it's a TTL-interfaceable RGB model), but if you want to buy a monochrome monitor that will work with the monochrome interface card which IBM offers for the PC, you'll have to choose a CRT that has a nonstandard vertical sweep frequency of 50-Hz.

INSTALLING A MONITOR

Monitors come in an almost unlimited variety of shapes and sizes. Models with 9-inch, 12-inch, and 13-inch sizes are all popular. And giant monitors with screens of up to 25 inches (measured diagonally) are also available. Even projection TV systems can be used with computers, if what you want is a giant playfield for computer games or a unit with a poster-size screen for graphics displays.

The size you pick is up to you, but the model you buy should produce sharp graphics, with text characters that are easy to read.

If you intend to spend a lot of time with your computer, you might want to consider the fact that a smaller-screen monitor can be easily placed on top of a computer, while larger units must usually be placed farther away.

Connecting a computer to a monitor is a perfect job for a novice; there's nothing to it. Just pick up the video cable that comes with most computers, and plug one end into the computer's video output. Then plug the other end of the cord into your monitor's video input.

If your monitor doesn't work after you do that, it's probably because either your computer isn't working or you haven't plugged your monitor into the wall.[∞]

AMDEK COLOR I

Amdek's lowest-priced color monitor, the COLOR I, is a "plain vanilla" model, equipped with a standard composite video input. It has a built-in speaker and an audio amplifier, making it suitable for use with computer programs that have soundtracks (such as music makers, voice synthesizers, and action games).

The Color I has excellent specifications for a composite-input monitor. Its 13-inch, 90-degree in-line tube has a fairly fine 0.33 mm dot pitch and can produce an extremely clear, sharp color display of up to 960 text characters (24 rows of 40 characters each). The monitor has a screen resolution of 260 lines horizontally by 300 lines vertically and a band-

width of 4 MHz. It comes in an attractively designed beige cabinet with a built-in carrying handle and convenient front-mounted controls.

The Amdek Color I monitor can be used with a wide variety of microcomputers including the IBM Personal Computer and PC Jr., the Atari family of computers, the Apple II/II+ /Ile series, the Coleco Adam, the Commodore VIC-20, and the Commodore 64.

The Color I monitor is also available in a deluxe version, the Color I Plus, that is equipped with such extra features as a nonglare screen and a pair of headphones. The Color I weighs 25.6 pounds.

Amdek Corp., \$399

AMDEK COLOR II PLUS

Toothpaste and laundry detergent are not the only kinds of products that manufacturers regularly update and reissue in "new and improved" versions. It happens with computer products, too. Amdek, for example, has improved the performance of its popular Color II monitor and has christened it the Color II Plus.

The II Plus is an ultra-versatile RGB monitor. It has three separate color systems built in: one for IBM Personal Computers that have IBM color cards installed, one for IBM PCs equipped with Amdek's own Multiple Adaptor Interface (MAI) card, and a third for Apple computers equipped with RGB interface cards.

These three color systems are built into the Color II Plus in the form of a programmable logic array. The monitor features a switchable color-weighting matrix that accurately displays the sixteen colors offered by the IBM PC and Apple computers. The Color II Plus provides especially attractive graphics when used in combination with Amdek's new MAI board for the IBM PC.

Aside from the three programmable color systems, the Color II Plus has specifications that are identical to those of its predecessor, the Amdek Color II. It has a 13-inch 90-degree in-line picture tube and a bandwidth of 12 MHz. Its scan frequencies are 15.75 kHz horizontally and 60 Hz vertically. Its resolution is rated at 560 dots horizontally by 240 lines vertically, and it is capable of displaying 24 lines of text in full color, with up to 80 typed characters on each line.

The Color II Plus is housed in an attractive beige cabinet with a built-in carrying handle. It weighs 32 pounds.

Amdek Corp., \$559

AMDEK COLOR IV

Amdek is one of the world's leading manufacturers of video monitors, and one of Amdek's finest monitors is its Color IV model. The Color IV is an ultra-high-resolution, 13-inch unit compatible with any computer that has an RGB video output port, including the DEC Rainbow microcomputer and the IBM Personal Computer.

The Amdek Color IV has exceptionally high resolution specifications (720 dots horizontally and 420 lines vertically) and can display a total of 2,304 characters on its screen—24 lines of text, with up to 96 typed characters per line. Its bandwidth is 16 MHz, and its scan frequency is 15.75 kHz horizontally and 60 Hz vertically.

The monitor is available in two versions. One has an RS-107A analog RGB TTL input, which is compatible with the DEC Rainbow, and offers an infinite number of colors controllable by software. The other version has a digital RGB TTL input that can be used with many other types of personal computers, including the IBM PC. This version of the Color IV can reproduce eight individual colors, with two hues available for each color, for a total of 16 colors and hues.

The Color IV is housed in a rugged, handsomely styled cabinet built to hold up in harsh industrial environments and demanding commercial applications. The monitor's tube is a 0.31 mm dot pitch model designed for ultra-high resolution, sharp contrast, and accurate color reproduction.

The Color IV has a sharp, clear video display with little distortion. Its full range of user controls includes convenient, front-mounted contrast and brightness knobs.

The Color IV weighs 25.6 pounds. Like all Amdek monitors, it comes with a full two-year warranty on electronic parts, and a three-year video tube warranty.

Amdek Corp., \$995

AMDEK VIDEO 300/310A

Amdek makes a pair of moderately priced monochrome monitors that are very popular—with good reason. The units are the Video 300, a versatile monitor with a standard composite video input, and the Video 310A, a high-performance monitor with an intensity-controlled TTL input specially designed for use with the IBM Personal Computer.

Both the Video 300 and the Video 310A have 12-inch video tubes with deflection angles of 90 degrees. Both monitors are available with either green-on-black or amber-on-black displays. Also,

both units are light and compact. Each weighs only 17 pounds.

The Video 300 monitor has an excellent bandwidth rating of 18 MHz and can generate a crystal-clear 80-column by 24-line text display. Resolution is rated at 960 horizontal lines at the center of the screen and 800 lines at the screen's edges. The monitor has a reflection-free nonglare screen and a rugged industrial-grade cabinet with a built-in carrying handle.

The Video 310A's TTL input is specially engineered to accept the non-standard 50 Hz video signal generated by the IBM PC. The 310A is housed in an industrial-grade cabinet that has a built-in carrying handle and is designed to match the color and contours of the IBM PC. It has the same resolution and bandwidth specifications as the Video 300. And it also has a nonglare screen that reduces eye fatigue and eliminates distracting reflections.

Amdek Corp., Video 300, \$179 with green phosphor, \$199 with amber-on-black; Video 310A, \$230

APPLE MONITOR II

What's the best monochrome monitor to use with an Apple II, II+ or IIe? An excellent choice would be the Apple Monitor II, a new unit specially designed by Apple to be a perfect match for any computer in the Apple II computer family.

The Monitor II CRT has a 12-inch, high-contrast, nonglare screen that tilts back and forth inside its cabinet for comfortable viewing at any reasonable height. The cabinet is injection molded and color-coordinated with the cabinets of the Apple II series of personal computers.

This monitor has convenient front-mounted power on/off and contrast controls, and rear controls for brightness, height, and vertical hold. Inside are controls for image focus, vertical linearity, horizontal hold, and horizontal size. The tube's brightness is preset at the factory.

The Monitor II has a standard composite video input and can be easily connected to almost any microcomputer with a standard high-frequency RCA cord of the type of cord that comes with every Apple IIe.

The Apple Monitor II can display either high-resolution graphics or sharp, clear text of up to 80 typed characters by 24 lines. The unit has an 18 MHz video bandwidth and excellent resolution specifications: 900 pixels at midscreen (measured horizontally) and 800 horizontal pixels at the screen's corners. Its video tube is a nonglare, high-contrast CRT with a diagonal deflection angle of 90 degrees. Its scanning frequencies are 15.699 kHz

horizontally and 60 Hz vertically. Its horizontal linearity rating is less than 10 percent.

The Apple Monitor II is 14½ inches wide, 10⅝ inches high, and slightly less than 13 inches deep. It weighs 21 pounds.

Apple Computer, \$229

APPLE MONITOR III

The Apple Monitor III was designed to be used with the Apple III computer, but it can also be used with the new Apple III Plus, II, II+, and IIe. Because it has a standard composite video input, it can also be connected to any other kind of microcomputer with a composite video output port.

The Monitor III is a monochrome unit with a 12-inch green-on-black nonglare screen. Its high-performance video tube has a 90-degree deflection angle. The unit has an 18 MHz bandwidth and a horizontal resolution of 700 lines at midscreen and 500 lines at the screen's edges.

The monitor produces an 80-column by 24-line text display that's perhaps too sharp. When there's text on the screen, you can see clearly that each letter and number is made up of tiny lines. This can be annoying; the characters generated by the Monitor III would actually look better if their pixels blurred together a little more. The text produced by the Monitor III is easy enough to read, however, and the monitor does an outstanding job of displaying high-resolution graphics in monochrome.

The Monitor III is color-coordinated with the Apple III and is designed to sit neatly atop an Apple III or III Plus computer. It will also fit on top of any Apple II, II+, or IIe computer that is equipped with a special extension cover obtainable from Apple dealers. The monitor can be connected to almost any personal computer that has a standard video cable of the type supplied with all Apple II series and III series computers.

The Apple Monitor III measures 17¾ inches wide, 10⅝ inches high, and 12½ inches deep. It weighs 16½ pounds.

Apple Computer, \$249

AYDIN PATRIOT SERIES

Aydin Controls has been manufacturing studio-quality color video equipment for more than 15 years. Now Aydin also offers a line of three high-resolution color monitors called the Patriot series. They're not easy to find in computer stores, but if you can track them down, they're well worth the trouble. All three monitors in the Patriot series are made in the United States, are backed by 18-month

warranties, and are available in both composite-input and RGB-input versions.

The top-of-the-line Patriot monitor, the Model 8835, is a 19-inch unit with a resolution of 1,280 by 1,024 pixels (more than 800 pixels per line). The unit has an advanced design, fixed-conversion in-line electron gun with a dot pitch of 0.31 mm. The monitor's video bandwidth is 40 MHz, and its scanning frequencies are adjustable from 25 to 38 kHz horizontally and from 47 to 63 vertically. It has separate color and synchronization inputs, each with two BNC connectors.

The Patriot line also includes the Model 8830, a 19-inch .31 mm-pitch monitor with a horizontal resolution specification of more than 700 pixels per line and a capability of displaying more than 4,000 text characters on its screen. The Model 8830 has a bandwidth of 25 MHz, a horizontal scanning frequency adjustable from 15 to 25 kHz in three ranges and a vertical scanning frequency of 47 to 63 Hz.

The third member of the Patriot series is a 13-inch monitor, the Model 8810. The 8810 has a .31 mm-pitch CRT with a horizontal resolution of more than 600 pixels per line and a capability of displaying more than 3,000 characters on its screen. The monitor's video bandwidth is 25 MHz, and its horizontal scanning frequency is adjustable from 15 to 25 kHz in three ranges. Its vertical scanning frequency is 47 to 63 Hz.

Aydin also offers a broad line of high-resolution and ultra-high-resolution monitors specially designed for demanding studio and industrial applications. This series, called the 8000 line, includes monitors with both in-line and Delta-style electron guns. Aydin's Series 8000 monitors have high-resolution shadow-mask CRTs, high video bandwidth ratings, long-term convergence stability, and modular construction. The horizontal resolution of the monitors in the 8000 series ranges from 600 to more than 1,000 dots per line.

Aydin Controls, price unavailable

COMMODORE C-1701

The Commodore C-1701 color monitor was designed to be used with such home computers as the Commodore 64 and the VIC-20, but its quality is so high for its price that it has become very popular with owners of other kinds of computers, too.

The C-1701, a medium-resolution 13-inch monitor with two types of video inputs, can also be used with equipment such as videocassette recorders, video cameras, and videodisk players. It has a standard composite video input on its front panel and

separate luma (brightness) and chroma (color) inputs on its rear panel. It is also wired for sound; it has a built-in audio amplifier and speaker, and audio inputs are located on both its front and back panels.

Mounted on the C-1701's front panel, along with its audio input and composite video input, are a power on/off switch and an LED power indicator. Concealed beneath a flip-open front panel is a full range of easy-to-adjust controls.

The Commodore C-1701 has excellent specifications for a monitor in its price range. It has a horizontal resolution of 320 dots at midscreen, so it can easily display up to 25 lines of 40 characters each (for a total of 1,000 characters) on its screen. The monitor can also reproduce high-resolution computer graphics in full color with sharp reproduction, high contrast and excellent color accuracy. For this reason, the C-1701 is ideally suited for use with computers such as the Coleco Adam, the Atari computer family, and Radio Shack's Color Computers, as well as with its manufacturer's own VIC-20 and Commodore 64 machines.

Commodore does not publish list prices for its products, but the Commodore C-1701 monitor retails for less than \$240 in most computer stores.

Commodore Computer, \$240 or less

COMREX CR-5400

Comrex packed a lot of monitor into a tiny space when it designed its CR-5400, an ultracompact 9-inch monochrome monitor available in a choice of three different screen colors.

The Comrex CR-5400 measures only $8\frac{2}{3}$ inches high by $10\frac{1}{3}$ inches wide and weighs just $10\frac{1}{2}$ pounds. Its screen display is only $4\frac{1}{3}$ inches high and a little less than 6 inches wide, but good things definitely do come in this small package.

The CR-5400 has an exceptionally high bandwidth rating of 20 MHz and outstanding resolution specifications of 800 horizontal pixels at midscreen and 650 pixels at the screen's edges. The unit is available in the screen color of your choice: green-on-black, yellow-green-on-black, or amber on a black background. The CR-5400's sweep frequencies of 15.699 kHz horizontally and 47-50 Hz vertically. It works on standard house current and consumes just 27 watts of power. Its video display, although small, is bright, razor sharp, and easy on the eyes in all three screen colors.

If you need an ultra-light, ultra-portable monochrome monitor, it would be hard to go wrong with the Comrex CR-5400.

Comrex International Inc., \$99.95

COMREX CR-5600

The Comrex CR-560 monitor offers the consumer a rare combination—professional quality at a home computer price. The CR-5600 is a compact 12-inch unit available with either a green-on-black or an amber-on-black display. Its performance specifications are as good as those of many monitors costing much more.

The CR-5600 has an extraordinarily high resolution of 1,000 horizontal lines in the center of the screen and 800 lines at the screen's edges. The monitor's bandwidth is an impressive 20 MHz, and its sweep frequencies are 15.699 kHz horizontally and 47-60 Hz vertically.

The Comrex CR-5600 measures 11 inches high and $13\frac{3}{4}$ inches wide, and weighs $15\frac{1}{2}$ pounds. Its screen is $10\frac{1}{4}$ inches wide by $5\frac{3}{4}$ inches high. Its power consumption is 30 watts. The CR-5600 is UL listed, and it is approved as a Class B computing device by the Federal Communications Commission.

The Comrex CR-5600 offers microcomputer users exceptionally high quality at an exceptionally low price. It has one of the sharpest, clearest video displays available in any monochrome monitor, and it's also quite a bargain.

Comrex International Inc., Green screen \$139; Amber screen \$149

COMREX CR-6500

Looking for an excellent value in a color video monitor? If so, the Comrex CR-6500 may be just the CRT you've been searching for. It's a composite-input monitor with a 13-inch in-line tube, automatic degaussing (demagnetization), and a built-in audio amplifier and speaker. The CR-6500 is compact; it measures just $14\frac{3}{4}$ inches high by 15 inches wide by 17 inches high, and it weighs only $25\frac{1}{2}$ pounds.

In addition to its manageable size and price, the CR-6500 has many outstanding features. Its screen is an eyesaving nonglare black-matrix model with a viewing area measuring 11 inches wide by $8\frac{1}{4}$ inches high. The CR-6500 has a full range of user controls including contrast, volume, brightness, tint, color and vertical hold. Because of its standard composite video input, it can be used with practically any microcomputer and can be hooked up with a standard video cable. Its video input is a standard RCA-type jack, and it accepts a standard mini-plug connector.

The color accuracy of the CR-6500 is excellent, and it has very good contrast and sharpness for a monitor in its class. Its resolution is rated at 260

lines horizontally and 300 lines vertically—enough to reproduce a 40-column by 24-line text display without straining. Its sweep frequencies are 15.734 kHz horizontally and 60 Hz vertically, and its geometric distortion is rated at less than 2 percent of total picture height.

The CR-6500 is backed by a full 90-day warranty.

Comrex International Inc., \$325

THE GENIUS

One of the most unusual monitors on the market is The Genius, a smart monitor manufactured by Micro Display Systems (MDS). The Genius has a 15-inch vertical screen, and can therefore display a complete page of 80-column text in a format that is an exact replica of a printed page.

The MDS Genius has a built-in set of 128 ASCII characters and can be purchased with foreign character sets, as well. Because the monitor has its own built-in 8K screen memory it places no more demands on its host computer than an ordinary, standard format monitor.

The Genius is available in two models. The Model 101 is compatible with the Apple II, II+, and IIe computers. The Model 102 can be connected to almost any microcomputer through an RS-232 serial port. The Model 102 is especially well suited for use with the IBM Personal Computer and IBM PC-compatible machines.

Each model of The Genius can display 57 lines of 80-column text in either normal or reverse video. It can also be used as a standard-sized monitor with either a 40-column width or an 80-column width in its Apple-compatible version or an 80-column by 25-line format in its IBM/RS-232 configuration. In addition, the monitor can be used in a bit-mapped mode, with a screen display that measures 720 by 990 pixels.

The Genius has a sharp, clear video display in a choice of three screen colors: black-and-white, green-on-black, and amber-on-black. Its resolution specifications are 720 lines horizontally by 900 lines vertically, and its video bandwidth is rated as approximately 100 MHz.

In its Apple-compatible configuration, The Genius has 8K of built-in memory which it uses for screen updating. It therefore places no load on its host computer for any of its screen-refresh memory needs.

In its IBM/RS-232 configuration, the monitor is additionally equipped with a Z-80 microprocessor chip and an 8K screen data buffer. ASCII data is transmitted to the monitor via a standard RS-232

port, and block data transfer is expedited with the help of a DMA (direct memory access) controller.

The monitor stands 13 inches high, and measures 13 inches wide and 17 inches deep, and it weighs 30 pounds. It can also be purchased as part of a keyboard-equipped terminal. In fact, two terminals built around The Genius are available.

The Genius comes with a 90-day warranty, and its manufacturer has a network of 170 maintenance centers across the country.

Micro Display Systems, Inc., Model 101 and 102 \$1,395

THE GORILLA

The Gorilla, a budget-priced monitor from Leading Edge, is a 12-inch green-screen monochrome unit with an 18 MHz bandwidth. It has a built-in tilt bracket that allows the user to adjust its screen to a comfortable angle, and it has a specially designed nonglare video tube that provides a clear, sharp, bright display of either high-resolution monochrome graphics or a screenful of text measuring up to 80 columns by 25 lines.

The Gorilla comes in a handsome neutral-colored cabinet with a built-in carrying handle. There are convenient front-panel controls for adjusting contrast and brightness and for turning the monitor off and on. The Gorilla offers as readable a display as some models with much higher prices.

Leading Edge Products, Inc., \$99

HITACHI MM-1218

The MM-1218 monitor from Hitachi is a trim, lightweight monochrome unit with a high-impact beige plastic cabinet and a bright, square-cornered, 80-column green screen. It has a 12-inch, nonglare video tube designed with a 90-degree deflection angle and coated with P39 green phosphor. It can reproduce up to 24 rows of 80-column text with each text character measuring 7 by 9 dots.

The Hitachi MM-1218 has a fairly high bandwidth rating of 15 MHz and fast scanning frequencies of 15.75 kHz horizontally and 60 Hz vertically.

The MM-1218 is a solidly built monitor, but it is also light and compact; it measures just 12.9 inches wide by 11.5 inches high by 12.6 inches deep, and it weighs only 15.5 pounds. Its screen display area is 8 inches wide by 6½ inches high, and it will work with any computer that has a standard composite video signal.

Hitachi Sales Corp., \$222.95

HITACHI CM-1481B

The Hitachi CM-1481B is a 13-inch monitor with excellent color capabilities but whose resolution specifications are on the low side (260 lines horizontally and 300 lines vertically). What those specs mean is that the CM-1481B is best suited for use with computers that have screen displays measuring no more than 32 typed characters across the screen.

Thus if you're the owner of a VIC-20 or a Radio Shack Color Computer, the CM-1481B may meet your needs. But, if your computer generates a text display of 40 characters per line or more (most personal computers currently on the market do), then it would probably be a good idea for you to pick a monitor with higher resolution specifications than those of the Hitachi CM-1481B.

If your computer is compatible with the CM-1481B, you'll probably be pleased with the quality of the monitor's display. The unit has a well-designed 90-degree in-line video tube with an easy-on-the-eyes non-glare screen. The monitor can display either text or graphics in full color, with a maximum screen display of 768 characters (up to 24 lines of 32 columns each) with each character measuring 8 by 8 dots.

The color capabilities of the CM-1481B are excellent and, except for its below-average resolution figures, its performance specifications are quite good. Its horizontal scanning frequency is 15.75 kHz, and its vertical scanning frequency is 60 Hz. It measures approximately 17 inches wide, 14¾ inches high, and 15 inches deep, and it weighs 25.6 pounds. The viewing area of the screen measures 11 inches wide by 8¼ inches high. It consumes 73 watts of power.

The CM-1481B has a built-in two-watt audio amplifier and speaker and is equipped with a standard composite video input. It is housed in a good-looking light beige cabinet made of high-impact plastic. It has two conveniently mounted front-panel controls: a contrast knob and a volume control with a built-in on/off switch. Other controls are concealed beneath an easy-to-reach front-mounted flip-open panel.

Hitachi Sales Corp., \$379.95

THE MICROTOUCH POINT-1 MONITOR

You won't have to lay a finger on a keyboard to use your microcomputer if it's hooked up to a Point-1 Computer Monitor, manufactured by the Microtouch company of Woburn, MA. The Point-1 monitor has a touch-sensitive screen, so you can

literally point out what you want your computer to do, and it will do it. With the Point-1's touch screen, you can make just about any microcomputer do just about everything a microcomputer is supposed to do—except type, of course. For that you'll still need a keyboard.

Point-1 monitors are available with screens of various sizes, and with both amber and green displays. The Point-1 touch screen can be used for selecting functions from a menu, for entering commands, and even for cursor control. There are no keys to worry about if you're a klutz at the typewriter, and no more looking up and down to see if what you've typed was correct. And the entire screen is touch-sensitive—not just certain parts. The whole screen can be used either for creating your own computer graphics, or for the entry of commands.

An intelligent controller with an 8-bit microprocessor for a brain is the secret behind the Point-1 monitor's response to the touch. Because of this processor, the Point-1 can interact with its user smoothly and easily, and can handle both text and graphics at lightning speed.

Point-1 monitors have a handsome family look, with screens that tilt back slightly for easier viewing. In the base of the monitor there's a recessed nook that a keyboard can be tucked into—or the keyboard can be positioned away from the screen with the help of a coil cable (provided). The terminal can be linked to most host computers, microcomputers, and computer terminals through a standard RS-232 port.

Software tools for the Point-1 Personal Computer Monitor include *Drive*Point*, which can be used to program the touch-screen controller, and *Command*Point*, which can turn the processor into a coprocessor, allowing the host computer to run one program while the monitor processes another. In addition, there's a *View*Point* software package that lets you test and construct new designs in minutes; with *View*Point*, you can create screen layout windows and icons by drawing them onto the screen. Then you can define touch-sensitive regions of the screen and link them to your application code—all by touch.

Microtouch, Monitor \$1,495; Kit with touch screen, controller and processor \$995; *Drive*Point* \$75; *Command*Point* \$95; *View*Point* \$445

MITSUBISHI'S MONITORS

Mitsubishi, one of the largest industrial companies in Japan, manufactures a broad line of com-

puter monitors that range from modestly priced monochrome units to some of the finest ultra-high-resolution color models available anywhere. Mitsubishi builds CRTs for every application you can think of, and then some, and is the actual manufacturer of many monitors sold under other companies' brand names. In fact, the company declares, Mitsubishi manufactures more than half of the high-resolution video monitors on the market.

Since many of Mitsubishi's monitors are used in professional applications, and since many more are marketed under other companies' names, a lot of Mitsubishi's monitors are sold without enclosures. Some of these "naked" monitors wind up installed in equipment racks and others end up in enclosures designed by other companies, but some Mitsubishi CRTs do come in finished cabinets that bear their manufacturer's brand.

Mitsubishi offers two fully-clothed, ready-to-use monochrome monitors you might run across if you're on a quest for the perfect CRT. One of these units is the NV-1260X, a 13-inch monitor capable of reproducing up to 2,000 characters on its green phosphor screen. This monitor has a bandwidth of 18 MHz and scanning frequencies of 15.75 kHz horizontally and 60 Hz vertically. It weighs 13½ pounds and has a power consumption of 30 watts.

The other model is the Mitsubishi NV-0960Z, a 9-inch unit with a black-and-white screen and a horizontal resolution of 600 lines. It has a bandwidth of 15 MHz and scanning frequencies of 15.75 kHz horizontally and 60 Hz vertically. It weighs 11½ pounds and consumes 30 watts of power.

Mitsubishi also offers several modestly priced RGB color monitors in finished 13-inch units that look very much alike but have significantly varying capabilities.

The AT-1341A is an 80-column monitor with a bandwidth of 20 MHz and resolution specifications of 640 dots horizontally and 400 lines vertically. It has scanning frequencies of 26.4 kHz horizontally and 60 Hz vertically, and is capable of displaying up to 16 colors.

The AT-1331A monitor is an 80-column unit with the same resolution specifications as the AT-1341A. But its bandwidth is rated at only 15 MHz and its scanning frequencies are 15.75 kHz horizontally and 60 Hz vertically. It has an eight-color display.

The Mitsubishi AT-1301B is a 40-column RGB monitor with resolution specifications of 400 dots horizontally and 200 lines vertically. It has scanning frequencies of 15.75 kHz horizontally and 60 Hz vertically, and it can display eight colors on its screen.

Mitsubishi also offers an extensive line of ultra-

high-resolution color monitors that have composite video inputs and are capable of generating displays of up to 9,000 characters on their screens. The most sophisticated monitors in Mitsubishi's ultra-high-resolution series have Delta-type electron guns, which produce triangular clusters of red, green and blue dots on a picture tube instead of the straight lines of dots produced by conventional in-line guns. Because of their Delta-gun design, Mitsubishi's highest-resolution monitors can be built with extraordinarily fine 0.20 mm dot-mask tubes, compared to the dot pitch of 0.31 mm or so that is typical of conventional in-line tubes.

All of the Delta-gun monitors in Mitsubishi's super-high-resolution CRT line are designed to be used with professional-quality computer and video equipment, and are therefore equipped with studio-style BNC analog inputs. Most of the monitors in this series are designed to be rack-mounted and are not offered in cabinet-enclosed versions. The few units that are available in cabinets include:

- The C-3910, a 13-inch monitor with a 4,000-character display capability, a video bandwidth of 50 Hz to 25 MHz, and sweep frequencies of 15-18 Hz horizontally and 40-70 Hz vertically.
- The C-6912, a 19-inch monitor with a 7,000-character display capability, a video bandwidth of 50 Hz to 50 MHz, and scanning frequencies of 28-34 Hz horizontally and 40-70 Hz vertically.
- The C-8912, a 19-inch monitor with a 9,000-character display capability, a video bandwidth of 50 Hz to 55 MHz, and scanning frequencies of 37-45 Hz horizontally to 40-70 Hz vertically.
- The C-3510, a 25-inch monitor with a 4,000-character display capability, a video bandwidth of 50 Hz to 25 MHz, and scanning frequencies of 15-18 kHz horizontally and 40-70 Hz vertically.
- The C-6512, a 25-inch unit with a 7,000-character display capability, a video bandwidth of 50 Hz to 50 MHz, and scanning frequencies of 28-34 kHz horizontally and 40-70 Hz vertically.

Mitsubishi Electric America, Inc., prices for all models to be set by dealer

NEC JC-1216DFA

NEC, one of Japan's top computer and video manufacturers, is justly proud of its JC-1216DFA color monitor. A versatile 12-inch RGB model with a direct-drive TTL input, it is compatible not only with NEC's own PC-8000 and PC-8800 computers but also with the IBM Personal Computer and PC-compatible machines.

The JC-1216DFA has a bright, ultra-high definition, high-contrast screen that can generate both

text and high-resolution graphics in stunning color. The screen is a black-matrix, in-line model with ultra-fine 0.30 mm dot spacing. Because of its advanced design, the JC-1216DFA can display 2,000 text characters (up to 25 rows of 80 characters each) in colors that are among the truest in the video industry. The resolution of the monitor's video image is also outstanding: 640 dots horizontally by 240 lines vertically. The monitor's bandwidth is 10 MHz, and its scanning frequencies are 15.75 kHz by 60 Hz.

The JC-1216DFA measures approximately 16 inches wide by 13 inches high by 14 inches deep, and it weighs 23 pounds. Its video display area is 8.85 inches wide by 6.29 inches high. It has convenient controls that make it easy to adjust the brightness, vertical hold and horizontal hold of its display. The monitor's beige cabinet is quite attractive, and it's an energy-saver, too, with a power consumption of just 62 watts.

NEC Home Electronics (U.S.A), Inc., \$599

PANASONIC CT-160

The Model CT-160 monitor from Panasonic is a double-duty unit. With the flip of a switch, it can be converted from a composite color monitor to a unit with a monochrome display.

The CT-160, equipped with a 10-inch screen (measured diagonally), was designed for both home computer and small business applications. In its full-color mode, it can reproduce sharp, clear color displays that are ideal for running colorful home computer software and playing video games. Flip a convenient front-panel switch, and the screen changes from a rainbow of color to a sharp black-and-white data display suitable for business programs and other software designed for use with a monochrome monitor.

In both its color mode and its monochrome mode the CT-160 can easily reproduce a 1,000-character screen of up to 25 lines with 40 typed characters each. This makes it suitable for use with a wide variety of personal computers, including the Coleco Adam, the Atari family, the VIC-20, the Commodore 64, and many more. The Panasonic CT-160 accepts a composite video input signal and has a built-in audio amplifier and a speaker that allow it to reproduce the audio signals of music and speech synthesizers as well as the sounds generated by computer games.

The CT-160 is equipped with a standard 75-ohm video input. It is UL-listed, and it carries an FCC certification as a Class B computing device.

Panasonic Industrial Company, \$399

PANASONIC DT-D1300D AND DT-D1000G

Panasonic now offers two high-resolution color monitors that are equipped with RGB inputs and designed to be used with such mid-priced personal computers as the Apple III and the IBM PC. One of these new monitors is a 13-inch unit with both an RGB input and a composite video input. The other unit is a 10-inch RGB model.

The 13-inch unit is called the DT-D1300D. It has an ultra-dark tube surface for high contrast and a direct-etched faceplate designed to reduce glare. It can produce an 80-column by 25-line text display in its RGB mode and a 40-column by 25-line display when its composite input is used. The DT-D1300D will accept any composite video input with a looping connector. Its alternate RGB input is a multi-pin connector that will accept a wide variety of connecting cables. This design allows the monitor to be connected to a wide range of popular computers. In its RGB mode, and with the proper cable, the DT-D1300D can be directly connected to the IBM PC, the Apple III or other 16-color microcomputer systems. The DT-D1300D has a built-in audio system and carries a limited one-year warranty on parts and labor.

Panasonic's 10-inch RGB monitor, the Model DT-D1000G, can generate a display of up to 2,000 characters (25 lines of 80 columns each). The DT-D1000G has built-in RGB interface circuitry and a multi-pin input connector. Like the DT-D1300D, it will generate a 16-color display when connected to an IBM PC or an Apple III computer by optional interconnect cables.

Both the DT-D1300D and the DT-D1000G are UL-listed, and both carry FCC certification as Class B computing devices.

Panasonic Industrial Company, DT-D1300D \$500; DT-D1000G \$450

PANASONIC TR-120M1P AND TR-120MPDA

Panasonic has introduced a pair of rugged, high-quality monochrome monitors designed to meet the increasing needs of the personal computer and small-business computer markets. Both monitors are high-resolution units with 12-inch CRTs, but one is a green-screen unit and the other has an amber-on-black display. Each monitor is equipped with a video looping connector, and each has a built-in audio speaker and amplifier.

Both the TR-120M1P and the TR-120MPDA feature direct-etched faceplates to minimize flare as well as sharp, high-resolution (1,100 lines) displays. Each unit boasts a wide video bandwidth of

20 MHz and can easily generate a 2,000-character screen display of up to 80 columns of characters and up to 25 lines of text.

The Panasonic TR-120M1P and the Panasonic TR-120MPDA are UL-listed and carry FCC certifications as Class B computing devices.

Panasonic Industrial Company, TR-120M1P \$220; TR-120MPDA \$240

PGS HX-12

The PGS HX-12 RGB monitor is one of the finest color CRTs available for use with the IBM Personal Computer. The HX-12 has an ultrafine .31 mm dot pitch, an outstanding resolution of 690 dots horizontally and 240 lines vertically (non-interlaced) and scan frequencies of 15.75 kHz horizontally and 60 Hz vertically. The video bandwidth of the HX-12 is 5MHz, and it can display up to 2,000 characters in 25 rows of 80 columns each on its 12-inch screen.

The video tube used in the HX-12 is a nonglare black-matrix model manufactured by NEC. A spokesman for PGS said that the NEC tube was selected because it combines the advantages of a nonglare screen with superior color convergence—the result is clean, sharp colors and crisp white without red bleed. Independent viewing tests have shown that the PGS HX-12 monitor lives up to this claim. The size of the HX-12's screen display area is approximately 8½ inches by 6¼ inches. Misconvergence is rated at a maximum 6 mm at the center of the screen, and a maximum of 1.1 mm at the screen's corners.

The PGS HX-12 monitor is designed to match the IBM PC in color, finish and contours. The cabinet is IBM beige, and it measures 11 inches high, 14¾ inches wide, and 15½ inches deep. The monitor comes with a cable that plugs directly into any IBM PC or IBM PC-XT equipped with a standard IBM PC or PC-compatible color graphics card.

Princeton Graphic Systems, \$695

PGS MAX-12

Princeton Graphic Systems, famous for its high-quality color monitors, now offers a monochrome model, the MAX-12, a 12-inch unit with a nonglare amber-on-black phosphor screen.

The MAX-12 was designed to be used with the IBM Personal Computer and, unlike most amber monitors, it is fully compatible with the IBM PC without the addition of any specially designed interface circuitry. The MAX-12, like the green-screen monochrome monitor marketed by IBM for the PC,

can be operated directly from the IBM PC's standard monochrome monitor card. The MAX-12 is a perfect match for the IBM PC outwardly as well as electronically; its color, contours, and cabinet finish are all tailored to match the IBM PC.

The screen of the MAX-12 monitor uses P34 amber phosphor which, according to PGS, is "the ergonomic standard in many European countries." C.T. Wu, president of PGS, says that the P34 phosphor was selected because it has been shown to reduce eye fatigue significantly and also because it has a shorter persistence on the screen than standard P39 green phosphor. "This feature eliminates the ghosting effect experienced when scrolling on a P39 green monitor," Mr. Wu notes.

The PGS MAX-12 monitor has a 720 dot by 350 line resolution and a bandwidth of 18 MHz. Its tube has a 90-degree deflection angle and a display that measures 8 inches horizontally and 5½ inches vertically. Its scanning frequencies are 18.432 kHz horizontally and 50 Hz vertically. The PGS MAX-12 has a power consumption of 30 watts.

Princeton Graphic Systems, \$249

PGS SR-12

Princeton Graphic Systems, better known as PGS, has a well-deserved reputation as a manufacturer of top-quality, state-of-the-art computer monitors. Now PGS has an RGB model of supermonitor quality. The unit is called the SR-12, and it is designed to be used with the IBM Personal Computer, the IBM PC XT, and IBM PC-compatible computers such as those made by Compaq, Corona, Eagle, Columbia, and Hyperion.

The SR-12 is a 12-inch color monitor with a black-matrix nonglare screen. The screen has a 90-degree in-line gun and a fine 0.31 mm dot pitch, and it displays an extremely high-quality, flicker-free image that is as suitable for business applications as it is for computer graphics.

The PGS SR-12 has a horizontal resolution of 690 dots and a superb vertical resolution specification of 480 lines, which has been achieved without resorting to line-interlacing circuitry. The unit's bandwidth is a spectacular 25 MHz, and its scan frequencies are 27.5-31.5 kHz horizontally and 60 Hz vertically. It can display up to 25 rows of 80 characters for a total of 2,000 characters on its screen.

The SR-12 is housed in a handsome, rugged cabinet that is tailored to match the color, finish and contours of the IBM PC. The monitor can accurately reproduce all 16 colors generated by the PC.

Princeton Graphic Systems, \$799

PROTON 600M

Proton is not a computer company, but rather a manufacturer of extraordinarily high-quality audio and video components. The Proton 600M color video monitor was not actually designed to be used as a computer monitor; it was intended to be the picture-reproducing element of a home video system. Nevertheless, the Proton 600M monitor has become something of a status symbol among home computer owners because it is, quite simply, one of the best home video monitors available anywhere.

The Proton 600M is a 19-inch color monitor that stands 18 inches high and measures 21½ inches wide and 19 inches deep. That makes it slightly larger than an average 19-inch television set, even though it doesn't have a built-in tuner for receiving television broadcasts, as ordinary TV sets do.

The 600M monitor is equipped with both a standard composite video input which is compatible with most personal computers and an RGB input which can be used with such RGB-interfaceable computers such as the IBM PC.

But don't let that RGB input fool you. Even though the Proton 600M is an exceptionally high-quality home video monitor, it was not designed to be used with computers that generate 80-character text lines and it is not capable of clearly reproducing an 80-column text display. The resolution specifications of the 600M fall somewhere between those of a standard TV set or a composite video monitor and those of a full-fledged RGB computer monitor. So, while the 600M can do a great job of generating the medium-resolution displays of 40 columns or so that are required by home computers in the Atari-Commodore class, it is not quite up to the task of producing the ultra-high-resolution color displays that are needed for the text displays of 80 columns or more that can be generated by more sophisticated computers such as the IBM PC.

When the Proton 600M is not asked to exceed its capabilities, its overall quality is nothing short of incredible; it can produce crystal-clear video images with astounding sharpness and bright, true colors. The horizontal resolution of the 600M is rated by Proton at greater than 350 lines, a figure considerably better than the 260 lines or so generated by an ordinary TV set but not nearly as impressive as the 650 lines or more offered by some top-rated RGB computer monitors. To Proton's credit, though, the resolution specifications it claims for the 600M have been shown to be somewhat conservative. Independent tests have demonstrated that the horizontal resolution of the 600M is actually as high as 370 lines or more, quite a bit better than its manufacturer claims.

The 600M's video bandwidth is rated at greater than 4.7MHz, and its geometric distortion is rated at no greater than 2.5 percent (typically 0.7 percent). Its power consumption is 80 watts, and it weighs 60 pounds.

Since the 600M was not designed with computers in mind, it has one other feature that could be considered a disadvantage in some computer applications: the large size of its screen. While a big screen is a definite plus when it comes to playing arcade-style games, the poster-size text that the Proton 600M's screen produces when it is being used for jobs such as word processing can become annoying to look at after awhile.

If you own a medium-resolution color computer and like to run educational software or play colorful action games, then the Proton 600M may be the monitor for you. Once you own it, you can start adding other components that can allow it to be the viewing screen of a complete home video system as well. But if you own a high-resolution computer and intend to run a lot of business oriented software—particularly 80-column software—then the 600M is probably not the monitor you need.

Proton, \$650

QUADCHROME

The Quadchrome, from Quadram Corporation, is a 12-inch RGB color monitor designed to be used with the IBM Personal Computer and with PC look-alikes. It is built around a specially designed NEC .31 mm dot pitch picture tube that delivers a razor-sharp, brightly colored image with a resolution of 690 dots horizontally and 480 lines vertically. It can be used for a wide variety of business-oriented applications, such as word processing, financial management and home and business management, as well as for running educational software, creating computer art, and playing computer games.

Quadchrome will deliver up to 16 colors. It has convenient front-panel user controls as well as a front-panel power-on LED indicator. The monitor is UL listed and is certified as a Class B computing device by the Federal Communications Commission.

Quadram Corporation, \$795

QUADSCREEN

Quadram's Quadscreen monitor is a giant 17-inch RGB color unit that can display 10,240 typed characters—enough to fill a whole spreadsheet on its screen simultaneously. It can accomplish this feat without pushing any data off the edges of its screen.

There are two secrets to Quadscreen's capacity: terrific resolution and the generous size of its screen. The Quadscreen can generate a text display that's up to 160 typed characters wide and up to 64 inches long. You can use this mammoth display in two ways to work with a full sheet of data—a database or spreadsheet, for example, or to place two completely different pages of text next to each other so as to view both pages simultaneously. In this double-page format, each page can be up to 80 typed characters wide and as many as 64 lines long.

The Quadscreen can also be used in a bit-mapped graphics mode. When bit mapping is done, the user can individually address every dot in the Quadscreen's display: 960 horizontal dots by 512 vertical dots, for a total of 491,520 pixels. The monitor can therefore be used to display an infinite variety of user-definable character fonts in any size in addition to ultra-high-resolution graphics and standard text displays.

The Quadram Quadscreen, designed for use with the IBM Personal Computer and PC-compatible machines, comes with a video controller card that has 128K of memory built in. It is available with two kinds of screens: a P24 amber tube or a P39 green phosphor display. Both models can display characters in reverse video, and both are equipped with forward and reverse find scrolling capabilities.

The Quadscreen monitor includes a cable, a controller board and a specially designed software package.

Quadram Corporation, \$1,995

RGBVISION I AND RGBVISION III

Both the RGBvision I and RGBvision III color monitors are fully compatible with the IBM PC and the Apple III and III Plus computers, and both can also be used with Apple II, II Plus and IIe computers equipped with a Taxan RGB Interface card. In addition, the RGBvision I and III monitors have composite video inputs that allow them to be used with most other types of personal computers.

Both monitors are equipped with linear-amplifier video circuitry and 12-inch, 90-degree deflection CRT displays. The RGBvision III also boasts an eye-saving black-face, nonglare screen.

The RGBvision I is a medium-resolution unit (380 horizontal lines at the center of the screen), but the RGBvision III has a very high resolution of 630 horizontal lines at midscreen. The Model I has a bandwidth of 15 MHz; the bandwidth of the Model III is 18 MHz.

Both units measure 12.5 inches wide by 15.1

inches deep by 11.4 inches high, and both have screen display areas that measure 8.5 inches by 6.3 inches. They each have the same weight 27½ pounds.

Taxan Corporation, RGBvision I \$399.99; RGBvision III \$629.95

RGBVISION 210

The Taxan RGBvision 210 is two color monitors in one. It's equipped not only with a standard composite video input but also with an RGB input that's compatible with the demands of ultra-high-resolution color computers such as the IBM PC. It can also be used with an Apple II Plus or Apple IIe that is equipped with an RGB interface card.

The RGBvision 210 has a 12-inch screen that can reproduce either a high-resolution RGB display or a medium-resolution composite video image. When the monitor is used in its RGB mode, it has a 15 MHz bandwidth and a horizontal resolution rating of 380 lines at the center of the screen, and it can generate a screen display 25 lines deep by 60 characters wide. In its composite mode, it can display twenty-five 40-character lines.

The Taxan RGBvision 210 has a builtin audio speaker with a 2-watt amplifier, and it can display more than 256 colors. It measures 12.6 inches wide by 15.4 inches deep by 11.4 inches high, and its screen display area is 9.4 inches wide by 6.9 inches high. It weighs 26½ pounds.

Taxan Corporation, \$399.99

RGBVISION 420

The 12-inch RGBvision 420 from Taxan is designed to be truly compatible—cosmetically as well as electronically—with the IBM Personal Computer. The RGBvision 420 is custom-tailored to be a perfect match for the IBM PC, from its PC-like light beige color to its PC-textured finish to its carefully contoured PC-look lines.

The Taxan RGBvision 420 is engineered to match the IBM PC's performance, too. The monitor's horizontal resolution is an impressive 640 lines at midscreen, and its video bandwidth is rated at 18 MHz. It has a black-stripe, non-glare picture tube with a 90-degree deflection and a 0.38 mm dot slit, and it is equipped with a mode switch that enables it to be used with both IBM and non-IBM computers.

The monitor also has convenient, easy-to-reach controls for adjusting contrast, horizontal hold, vertical hold, and screen size. It comes with a full one-year warranty on parts and a limited warranty on labor. The RGBvision 420 includes a video cable that fits an IBM PC.

Taxan Corporation (formerly TSK Electronics Corporation), \$699.90

SAKATA SC-200

The Sakata Model SC-200 is a high-quality 13-inch color monitor that is specially engineered for the computer user who is looking for RGB quality at a moderate price. The SC-200 offers a sharp, clear 80-character by 25-line display in up to 16 colors (8 colors, each with 2 hues), and it is compatible with a wide variety of high-quality personal computers, including the IBM PC as well as computers made by Apple, Fujitsu and NEC.

The SC-200 has excellent resolution specifications (640 dots horizontally by 240 lines vertically) and fast scanning frequencies of 15.75 kHz and 60 Hz vertically. Its price is relatively modest for an RGB monitor in its class.

The Model SC-200 has a 90-degree in-line tube with a 0.39 mm dot pitch. The monitor is equipped with a full set of convenient, easy-to-operate controls, including front-panel power switch and brightness control and rear-panel vertical position control. It is housed in an attractive, streamlined cabinet made of durable, neutral-color polystyrene that blends in well with almost any room decor. It measures 14¼ inches wide, 13¼ inches high and 16½ inches deep, and weighs 28½ pounds.

Sakata U.S.A. Corporation, \$649

SAKATA SC-300

One of the finest RGB monitors on the market is Sakata's top-of-the-line model, the 13-inch SC-300. The SC-300 is equipped with a state-of-the-art digital video amplifier circuit, and it has outstanding resolution specifications (720 dots horizontally and 240 lines vertically). Its scanning frequencies are 15.75 kHz horizontally and 60Hz vertically, and mis-convergence is rated at a maximum of 0.5 mm at the center of the screen.

The Sakata SC-300 offers a 2,000-character display—25 lines of 80 column each—and can accurately reproduce all 16 of the colors generated by the IBM PC and by PC-compatible computers.

The SC-300 has a high-resolution 13-inch, 90-degree in-line video tube. Dot pitch is an exceptionally fine 0.31 mm. The monitor measures 22 inches wide by 16⅔ inches high by 16½ inches wide, and it weighs 30.8 pounds. It consumes 65 watts of power.

Sakata U.S.A Corporation, \$899

SAKATA SG-1000

If you want a high-resolution monochrome monitor but don't want to pay a sky-high price, the new Sakata SG-1000 could be just the unit for you. Its resolution is superb—900 dots horizontally at mid-screen and 800 dots at the screen's edges—and it has an extra-generous bandwidth of 18 MHz. These excellent specs give the SG-1000 one of the sharpest, clearest screen displays around.

The Sakata SG-1000 has a 12-inch non-glare, high-resolution screen with a P31 green-phosphor display. The tube is a high-resolution model with a dark faceplate designed for high contrast and comfortable viewing. The monitor's scanning frequency is 15.75 kHz horizontally and 60 Hz vertically. Picture distortion is rated at 2.5 percent maximum both horizontally and vertically.

The SG-1000 is a versatile monitor with a composite video input that accepts a standard RCA plug. The monitor is therefore compatible with virtually every small computer on the market, including the Apple II family, the Atari family of computers, the VIC-20, the Commodore 64, Radio Shack's Color Computers, NEC's personal computers and the IBM PC.

The SG-1000 is housed in an attractive beige polystyrene cabinet. It measures 12⅓ inches wide, 11 inches high, and 12¾ inches deep, and weighs 16.5 pounds. Its power consumption is 27 watts.

Sakata U.S.A. Corporation, \$129

SANYO AVM-255

The AVM-255 25-inch monitor from Sanyo is one of the most versatile monitors on the market. It has both a composite input for computers with standard video outputs and an RGB input for ultra-high-resolution displays. And, in case that's not enough, it also has a green-screen monochrome mode that can be switched in at the touch of a button. Other features of the AVM-255 include a built-in 5-watt-per-channel audio amplifier, jacks for external speakers, a black-matrix picture tube and concealed front-panel controls.

The AVM-255 is part of Sanyo's Pro-Ponent line of modular video and audio components. Sanyo says that it is "a studio-quality monitor that offers ultra-high resolution from virtually any broadcast or direct video source."

Sanyo Electric, Inc., \$800

SANYO CRT-36

The Sanyo CRT-36 monitor is a ruggedly built

unit designed for years of trouble-free viewing. The CRT-36 has a 12-inch, 90-degree, green-phosphor screen, less than 2 percent geometric distortion and resolution specifications of 560 pixels horizontally and 240 pixels vertically. Its bandwidth is a hefty 18 MHz, and its scanning frequencies are 15.78 kHz horizontally by 60 Hz vertically.

The CRT-36's video tube is a non-glare model coated with P31 green phosphor. The screen's viewing area measures 8¼ inches by slightly less than 6 inches.

The Sanyo CRT-36 has a regulated power supply with an isolation transformer, and it has a standard composite video input. It measures 12.6 inches wide by 10.8 inches high by 12.8 inches deep, and weighs about 17 pounds. Its power consumption is rated at 36 watts.

Sanyo Business Systems Corporation, \$199

TAXAN MODELS 121 AND 122

It's difficult to find a monochrome monitor that's compatible with the IBM Personal Computer and isn't made by IBM. The IBM PC generates a 50 Hz monochrome video signal rather than the 60 Hz signals that are standard in this country; therefore it cannot be connected directly to most monochrome monitors built for the U.S. market. However, two of Taxan's newest monochrome monitors—the green-screen Model 121 and the amber-screen Model 122—are specially designed to be compatible with the IBM PC. Both monitors have extra-flat picture tubes for undistorted reproduction of text and graphics, slow-persistence phosphor screen coatings for flicker-free viewing and a bandwidth of more than 20 MHz for crisp, clear displays.

Except for their screen colors, the specifications of the Taxan 121 and Taxan 122 are identical. Both monitors have an horizontal resolution of 800 dots at midscreen, a bandwidth of more than 18 MHz, and scanning frequencies of 15.75 kHz horizontally and 49-61 Hz vertically. Both units are capable of displaying 24 lines of 80 text characters each, both have screen display areas of 8¼ inches by 6 inches, both measure 12¼ inches wide by 11¼ inches high by 12⅝ inches deep, and both have a power consumption of 28 watts and weigh in at 16 pounds.

The Taxan 121 and Taxan 122 have builtin carrying handles, and both units are available on an optional tilt-and-swivel base (the Taxan 110-12 with a builtin LCD clock). The swivel and tilt mechanisms in the base work independently—and snugly, too, so that no locking in place is required.

Taxan Corporation, Model 121 \$219.95; Model 122 \$229.95; Base Model 110-12 \$49.95

TAXAN MODELS KG12N-44 AND KG12N

The most affordable video monitors that bear the famous Taxan name are the Model KG12N-44, an amber-screen unit, and the KG12N, a green-screen model.

Aside from screen color, the KG12N and the KG12N-44 have identical specifications: a bandwidth of more than 18 MHz, an 800-line horizontal resolution at the center of the screen and a 2,000-character (80-column by 25-line) display. Both monitors measure 12¼ inches wide by 11¼ inches high by 12⅝ inches deep, both have standard composite video inputs, and each monitor weighs just 16 pounds.

Taxan Corporation, KG12N-44 \$189.95; KG12N \$179.95

TAXAN 210 COMPO-VISION

Bright colors and good resolution at a moderate price: these were the goals that Taxan set for itself when it designed its new 210 Compo-Vision monitor. Viewing tests show that the company has achieved its aim. Since the Model 210 has a composite input—a standard, non-RGB video interface—it can be used with almost any moderately priced personal computer.

The Model 210 Compo-Vision's video display is remarkably clear, sharp and bright for a monitor in its price range. It has a bandwidth of 7 MHz and a horizontal resolution of 400 lines. It includes a removable anti-glare screen and a builtin carrying handle.

Taxan Corporation, \$399.95

USI

USI Computer Products has been making computer components for 12 years and claims to be the company that brought the eye-saving amber monitor to this country. USI also modestly refers to its product line as "the recognized standard for amber monitors in the U.S.," and as the manufacturer of "the ultimate color monitor."

While other manufacturers might dispute some of those claims, USI definitely has a superb line of computer monitors and video-related peripherals. The USI line includes:

Four ultra-high-resolution monochrome monitors: the 900/G, the 1200/G, the 900/A, and the

1200/A. The 900/G is a 9-inch monitor with a green-on-black display, and the 1200/G is a 12-inch green-screen monitor. The 900/A is a 9-inch amber-screen unit, and the 1200/A is a 12-inch amber model. Each monitor in this series has an extraordinarily high horizontal resolution of 1,000 lines at midscreen, and an extra-wide video bandwidth of 20 MHz. All four monitors are housed in rugged metal cabinets, and each has convenient front-panel controls for adjusting contrast, brightness, vertical hold and horizontal hold.

A high-quality composite-input color monitor,

the 1400/C. The USI 1400/C, designed specially for personal computers, has a builtin audio amplifier and a speaker and can clearly display up to 1,000 typed characters 40 columns by 25 rows on its 14-inch screen. Its resolution specifications are 260 lines horizontally and 300 lines vertically, and its scanning frequencies are 15.75 kHz horizontally and 60 Hz vertically. It consumes 60 watts of power, and it is equipped with a generous selection of user controls.

USI Computer Products, 900/G \$199; 1200/G \$199; 900/A \$225; 1200/A \$225; 1400/C \$398

PRINTERS & PLOTTERS

There are so many variations in the quality, functions, and performance of printers intended for use with personal computers that price is never an indicator of how a particular printer will perform for you. Within every generic design and every price range there are seemingly endless variations in printer performance.

Excluding the high technology machines, such as the laser printer—which can turn out 3,000 lines of print per minute—or the ink jet printer capable of duplicating a color photograph, there are only two kinds of printers generally used with personal computers: the letter quality and the matrix printers.

A letter quality printer is one that will produce fully-formed characters resembling the print quality of a standard typewriter. Unlike a typewriter, however, the specialty printer has its own internal microprocessor, which can produce many different printing variations or “special effects” depending on the particular printer model. Among the most common variations are: “shadow” or “boldface” printing, caused by moving the print head and/or the paper slightly and then restriking several times; true superscripts and subscripts, produced by rolling the paper up and down; and variable underscore that will underline characters, words, or any number of words, sentences, or paragraphs. Also, most specialty printers can print with justified left and right margins, while others can provide a typeset appearance through proportional size characters and microjustification of the spacing between the characters.

Two kinds of printing mechanisms are in general use for letter quality printers: the daisy wheel and the thimble. The daisy wheel printer employs a plastic or metal wheel having a central core with radiating spokes that resemble the petals of a daisy. Each petal has a character located at the tip. To print a letter, the daisy wheel is rotated to position the desired character under a small hammer; this then strikes the tip of the petal against a ribbon, which transfers the character outline to the paper located in front of the ribbon.

In some printers the daisy printwheel has been bent so the petals form a cylinder and resemble a sewing thimble, from which we derive the term “thimble printer.” It prints the same way as the daisy wheel: a hammer strikes a petal against the ribbon.

Both the daisy and thimble printers employ interchangeable printwheels, or fonts. A font refers to the typeface of a complete set of characters. Most

letter quality printers permit selection of the type pitch, meaning the number of characters per inch. As a general rule, specialty printers can use either 10 or 12 pitch printwheels; others can also accommodate microtype, which is 16.5 to 18.5 characters per inch. The more expensive printers also provide for proportional wheels, which, as mentioned earlier, produce copy that appears to have been typeset.

Not all fonts, or even similar ones, are available for all letter quality printers, yet the available fonts might determine the kind of printer to purchase. In fact, all things considered, the available fonts are often the very first consideration when selecting a letter quality printer.

There are two general kinds of fonts for daisy printers: the “correspondence” font, with 88 characters representing the keys of a standard typewriter, and the 96-character ASCII font. (ASCII is the acronym for American Standard Code for Information Interchange.) The correspondence font omits several of the characters used in BASIC programs and some word processing programs. Among the missing characters are the left and right arrows (< and >), the reverse slash (\), the “up-arrow” (^) or carat, and the left and right braces ([and]) and curly braces ({ and }). These characters are normally provided only on the 96-character ASCII printwheels.

If the printer does not have an ASCII printwheel and it is used to list programs written in BASIC, the characters missing from the printwheel will be passed over, indicated by a blank space or filled by some other character. It is best for programmers to avoid a non-ASCII printer because it is an interminable, error-prone task to insert the missing characters into a listing. Similarly, if your document will refer to the missing characters they must again be entered by hand.

As a rule of thumb, if you must list BASIC programs or you write about high technology, you must have a printer that can print the full ASCII character set. Any kind of printwheel will suffice if you don't write programs, if you have no need for program listings, or if your documents are straight office-type correspondence or reports.

For some specialty printers, all or most printwheels are 96-character ASCII. For other printers there will be just one “universal” ASCII wheel available, in 12 pitch so it can be used on either a 10-pitch or 12-pitch machine. The 12-pitch wheel on a 10-pitch machine has very slightly greater spacing between the characters, otherwise it has a normal

appearance. If you must use a microtype font, make certain there is an ASCII printwheel available in microtype size.

The features and printing functions provided by a letter quality printer are sharply determined by price; as a rule, the more you pay the more you get, though even the more expensive models might not have the particular feature you need. The less expensive daisy printers are more or less the printing mechanism of a "electronic typewriter." In fact, some of the newer electronic typewriters from Olympia, Brother and SCM (Smith-Corona) accommodate an optional interface that permits a computer to drive the printing mechanism.

The less expensive daisy printers can print approximately 12 to 18 characters per second, which works out to about 120 to 180 words per minute: slow by computer standards but fast compared to a typewriter. The more expensive printers commonly used with personal computers print approximately 18 to 50 characters per second, which works out to about 180 to 500 words per minute. (For English estimate six characters per word, which includes spaces.) Except for the most expensive machines, the slower the printer the more precise the alignment of the characters tends to be.

Unlike the fully-formed characters of a letter quality printer, matrix printer characters are created from closely spaced dots produced when wires almost as thin as a hair strike the printer's ribbon. The wires, which are mounted in a "print-head" and arranged in a vertical line, are under the control of a built-in microprocessor. The microprocessor interprets the information from the computer and determines how the printhead and the paper will move, and what wires are to be fired at a given moment. Because the "characters" are created by the individual dots produced by the wires, virtually any kind of printout is possible: standard 10, 12, or microtype pitch characters; expanded or double-size characters; even graphics—charts, graphs, and pictures created by dots.

Since matrix characters are formed by printed dots there is initially a visible space between the dots. The characters are legible but obviously machine quality. However, the printing is done quickly because the head prints each line with a single pass. Matrix printing can start to approach the fully formed characters of a typewriter if the spaces between the dots are filled in with even more dots; the greater the number of filler dots the better the print quality. Matrix printers which can produce a high dot density that resembles fully formed characters are called "correspondence quality printers" because their print would normally be acceptable for general correspondence.

Correspondence quality may be attained by either printing more dots per character on the first pass of the printhead, or by rolling the paper a fraction of an inch and then printing over the line to fill in the spaces between the vertical dots, or by printing a slightly displaced second pass on each line, which fills in the spaces between the horizontal dots on each. Often these techniques are combined. The most modern matrix printers combine all printing enhancements: They use many dots for the initial character, leaving few spaces, and then fill in the vertical dots by moving the paper before a second pass. The combination of very high dot density and displaced pass produces characters almost—but never quite—the equal of a typewriter.

Just about anything is possible in typeface selection—even proportional characters—because the characters are created by dots. On instruction from a BASIC program, or applications software such as a word processor, a matrix printer can shift in and out of standard or expanded pitch, italics, foreign characters, and even symbols, character by character.

Though many kinds of fonts, graphic characters, and functions might be available from a matrix printer, the software often precludes the use of more than just a handful. There are several reasons for this; a common one is that a particular program might limit the user to four or six "user commands." This means that, at the most, the user could have the software control four to six printer functions. If one is for 10 pitch, another for 12 pitch, and a third for microtype, only one to three commands remain available for all the remaining printer functions—underline, double underline, ring bell, enhanced printing, end of page stop, skip over perforations, and so on.

Another reason matrix printers work well with some software and not others is that there is no accepted standard for the printer control codes. The graphics program that creates multilevel bar charts and sectioned pie charts on one kind of matrix printer might simply feed an endless length of paper from a different model. It is, therefore, most important for the user interested in graphics printing to confirm that a particular matrix printer will work with the desired software.

Letter quality and matrix printers are available for either "parallel" or "serial" input. Parallel and serial describe the way in which the electrical signals between the printer and computer are connected. A parallel printer receives data from the computer an entire byte at a time, each bit sent over its own wire; a serial printer receives the bits over a single wire, in a series, which is then reassembled into the original byte of data. For printers

used with personal computers, there is essentially no difference as far as the end product is concerned.

Almost without exception, all modern parallel printers are "Centronics-compatible"; they use the same connections as Centronic printers, which were the first to be used with personal computers. Any Centronics-compatible computer can be connected to any Centronics-compatible printer by simply connecting them with an appropriate cable. Minor variations in printer functions between Centronics-compatible equipments generally are resolved automatically by the connecting cable.

The same cannot be said for serial printers. Though they supposedly employ what is called the "RS-232C standard" configuration, in fact there is no effective standard. The serial printer that works with one computer won't work with others without modifications. For this reason serial printers generally have several internal "configuration switches"—usually arranged in multiswitch assemblies—which must be adjusted for specific computers, and in some instances, specific software.

Surprisingly, as far as personal computers are concerned, there is little advantage to serial printers; serial and parallel printers do exactly the same job, though serial printers often require a lot of fussing and hand-holding by the dealer before a nontechnical user gets it working properly. They are more reliable when the cable between the computer and printer is long—up to 100 feet or so—but few home installations are so widely spread as to require them. Serial printers also cost about \$100 more than equivalent parallel models. To avoid the problem of the printer that can't be conveniently used with more than one kind of computer, many of the newer printers accommodate both serial and parallel connections, the cost of the extra input being built into the cost of the printer.

We have not touched on printers that use heat sensitive paper, electric burn printing, or anything using paper that's less than standard letterhead width because they are not suitable for what is called "serious computing." Most "gadget printers" use nonstandard roll paper from 3 to 7 inches wide, from which the user tears off the printed section. Some utilize heat sensitive paper from which the printed image eventually fades, and all are not suited for business or commercial correspondence. As a general rule, these miniprinters are inexpensive models intended for use with entry level computers as a listing device for BASIC programs. In many instances, a real matrix printer doesn't cost much more.

Regardless of what type or brand of printer

you're interested in, bear in mind it must work with your computer and your software. If a printer employs special control codes for features you need, such as continuous underscore, superscripts or subscripts, be certain your computer or software can output them. If you need graphics capability, make certain the printer responds to the graphics of your computer or software—there are differences. Virtually no two printers respond identically to the same set of control codes.

THE ALPHACOM 42 AND THE ALPHACOM 81

No matter what kind of personal computer you own, Alphacom probably makes a printer to go with it—despite the fact that Alphacom makes only two printers.

Alphacom calls its printers the Model 42 and the Model 81. Both printers are thermal units, but the Alphacom 42 is a 40-column printer, while the Alphacom 81 is an 80-column unit. And both units are available with interfaces that enable them to be used with almost any personal computer on the market.

The Alphacom 42 includes an unusual interfacing system that makes it compatible with most popular home computers, including those manufactured by Atari, Commodore, Texas Instruments, and Timex. The Model 81 includes an interface cable that can make it compatible not only with Atari, Commodore, TI, or Timex computers, but also with any personal computer equipped with a Centronics-style parallel port or a standard RS-232C serial connector.

The secret behind the versatility of Alphacom's printers is a special type of "intelligent" connecting cable. On one end of each Alphacom cable, there's a connector that is designed to fit one specific type of computer or computer port. On the other end of the cable, there's a rectangular module a little bigger than a video-game cartridge. And that module contains all of the circuitry needed to make an Alphacom printer completely compatible with the type of computer for which the cable was designed.

When you buy an Alphacom printer, all you have to do is tell the salesman what kind of computer you own, and he will provide you with the proper cable. Then, when you get your printer home, you can simply plug one end of the cable into your computer, and the other end into your printer. That's all you'll have to do to make your computer and your printer compatible.

Both Alphacom printers use heat-sensitive roll paper and can print both text and bit-mapped, high-resolution graphics. Both printers use an Oli-

vetti dot-matrix print mechanism and contain a microprocessor chip that provides automatic word wrapping on the ends of printed lines.

The quality of printing turned out by Alphacom's printers is typical of what one would expect from inexpensive thermal units: not as good as that produced by most impact printers, and certainly not business quality. But the graphics produced by the two machines are quite impressive, the text is legible, and the printers are probably adequate for most home uses. It also should be understood that the main limitation in the printing quality of Alphacom's printers is not due to the machines themselves, but is rather the fault of the heat-sensitive paper that they use; thermal paper tends to be slick-feeling and oddly colored—usually silver or off-white—and comes in rolls, rather than cut sheets. So it's virtually impossible to turn out a neat, professional-looking printing job on any kind of printer that uses thermal paper. Both units are whisper-quiet, as thermal printers tend to be.

Alphacom's printers recognize the standard ASCII character set, plus "action" codes for printing functions such as carriage returns, line feeds, right justification, form feeds, multi-line feeds, and graphics control. The Alphacom 42 prints two lines a second, and the Alphacom 81 prints 100 characters per second.

Alphacom printers are made of lightweight, impact-resistant plastic, and their paper rolls are concealed inside their cases, giving them a sleek, uncluttered look.

Alphacom, Model 42 \$99.95; Model 81 \$215

AMDEK AMPLOT II PRINTER-PLOTTER

The Amplot II Printer-Plotter from Amdek Corporation of Elk Grove Village, Illinois is a six-color unit with a 10-inch by 14-inch plotting surface. It comes with a driver that enables it to be used with either *Lotus 1-2-3* software or with software specially designed by Amdek.

The Amdek Amplot II is an intelligent, microprocessor-driven plotter that accepts standard ASCII printing commands. It also has built-in software for arc and circle generation, windowing, and other functions. It has both RS-232C and 8-bit parallel interfaces built in, and it comes with a 90-day warranty, including both parts and labor.

Amdek Corp., \$1,099

ANADEX PRINTERS

What's the fastest printer in the personal computer industry? One unit that's a sure contender for that title is the Anadex Rapid/Scribe DP-6500,

which prints at more than 500 characters per second using standard pica (10-pitch) characters. The Rapid/Scribe also has a "correspondence" mode in which it can turn out printing of almost letter quality at 137 cps.

The Rapid/Scribe DP-6500 has proportional spacing capabilities, and can print in boldface or italics, and can also print double-width letters. It has a full ASCII character set, plus international and graphics character sets. It can also print dot-addressable high-resolution graphics with a density of up to 144 dots per inch. Its maximum line width is 13.2 inches.

The DP-6500 comes equipped with both a standard parallel interface and a standard RS-232C serial interface. It measures 29.5 inches wide by 18.4 inches deep by 8.9 inches high, and it weighs 55 pounds.

Anadex, based in Camarillo, California, also manufactures a wide range of other printers, including an ultra-deluxe multimode called the Word/Scribe WP-6000 and a full-color dot-matrix printer called the Color/Scribe DP-9725B.

The Word/Scribe WP-6000 can print letter-quality documents at a rate of 125 characters per second; correspondence-quality documents at 170 characters per second; and reports and drafts in a data-processing mode that runs at 230 characters per second. Pitch is adjustable from 6 to 16 characters per inch, and a number of letter-quality type styles are available. Additional fonts can be downloaded, and are optionally available in ROM. The Word/Scribe can print on paper up to 15 inches wide, and comes equipped with both parallel and serial interfaces.

The Color/Scribe DP-9725B can be used either as a full-color dot-matrix printer or as a versatile black-and-white printer. It has two printing modes: draft quality and correspondence quality. It can print at up to 240 characters per second, and it comes with a plug-in "Logi/Card" that is compatible with a wide variety of computers. An emulation disk is supplied with the Color/Scribe to make it compatible with the IBM Personal Computer and color monitor.

Other dot-matrix printers in the Anadex line are the Silent/Scribe DP-9620B, the Silent/Scribe DP-9625B, the Silent/Scribe DP-9500B and DP-9502B, and the Silent/Scribe DP-900B and DP-9001B.

Anadex, Rapid/Scribe DP-6500 \$2,995; Word/Scribe WP-600 \$2,700; Color/Scribe DP-9725B \$1,625; Silent/Scribe DP-9620B \$1,380; DP-9625B \$1,500; DP-9055B and -9501B \$1,280; DP-9000B and -9001B \$1,200

THE DAISYWRITER 2000

The Daisywriter 2000 is a high-quality, low-priced, feature-packed daisy-wheel printer manufactured by Computers International, Inc., of Los Angeles. It is moderately priced for a letter-quality printer in its class, and it has more features than many printers that cost far more.

One of the Daisywriter's most important features is a built-in Z-80 microprocessor that enables it to emulate the protocols of almost every other daisy-wheel printer on the market. And that is a very desirable capability; it means that you can use the Daisywriter 2000 with virtually any computer, and with just about any software program you may own.

Another special feature of the Daisywriter 2000 is a giant 48K print buffer. That's a rather incredible feature; it means that you can dump 48K of text into the printer at once, freeing your computer to do other kinds of work while the text is being printed.

Still another interesting feature of the Daisywriter is an ability to print in 16 languages—not only English and the usual European languages, but more exotic tongues too, ranging from Turkish to Hebrew to Icelandic to Japanese.

The Daisywriter 2000 is housed in a durable-looking plastic case, and uses a print mechanism manufactured by Brother, a well-known typewriter company. And it is compatible with ribbons made for IBM Selectric typewriters. It prints bidirectionally at a speed of more than 40 characters per second—a very fast rate for a daisy-wheel printer—and it has four interfaces: a standard Centronics-type parallel interface, a standard RS-232C serial interface, and IEEE-488 and 20 ma Current Loop connectors.

The printer measures 23.8 inches wide by 14.7 inches deep by 6.7 inches high, and it weighs 35 pounds.

Accessories that are optionally available for the Daisywriter 2000 include a tractor-feed mechanism, an automatic sheet feeder, and a 28-inch-high noise-insulated enclosure. The cabinet has a clear front and top, and a two-door cabinet underneath for storing supplies.

Computers International, Inc., \$1,495

THE DIABLO 620 API

The Diablo 620 API printer is designed primarily for small-business and office use, and is the lowest-priced model in the Diablo letter-quality line. It prints at a fairly rapid 21 characters per second.

Like the Diablo 630, the Model 620 is equipped with an API ("all-purpose interface") feature that allows it to be used with a wide variety of personal computers, including the IBM Personal Computer; the Apple II, IIe, and III; Commodore computers; Osborne computers; the North Star Advantage; and many more.

The 620 API uses a 98-character print wheel and has 3 print pitches: 10, 12, and 15 characters per inch. It has a bi-directional paper feed, and can handle paper up to 15.2 inches wide. Diablo says that 620 API printers operate an average of 4,000 hours without maintenance, and that when they do go down, require an average of 15 minutes to repair.

Diablo, \$1,095

THE DIABLO 630 ECS SERIES

The Diablo 630 ECS is a daisy-wheel printer designed specifically for use with the IBM Personal Computer, and its manufacturer says that it can print virtually every character that the IBM PC can display. The 630 ECS is plug-compatible with the PC, and Diablo says it is the first letter-quality printer capable of printing text and graphics within the same document without changing print wheels.

The 630 ECS uses an unusual print wheel that contains 192 characters, and with the use of more than one stroke, can construct 49 more. Because of its extended character set, the wheel can print in 33 languages. And, since the 630 ECS is also compatible with print wheels designed for the standard Diablo 630 printer, it can be used with nearly 200 different wheels.

The Diablo 630 ECS has most of the features of the standard Diablo 630 printer, but has a specially designed carriage assembly that can move up and down to accommodate its special printing features. It prints at speeds of up to 40 characters per second, and can handle paper up to 16½ inches wide. It is less than 10 inches high, and approximately 23 inches wide and 19¼ inches deep. It weighs less than 60 pounds.

Diablo, \$2,195

DYNAX AND BROTHER PRINTERS

Dynax, Inc., of Bell, California, now markets two daisy-wheel printers: the Dynax DX-15, which has a print speed of 13 characters per second and can accommodate paper up to 13½ inches wide, and the Brother HR-25, which prints at up to 23 characters per second on paper up to 16½ inches wide.

Dynax lets its retailers set their own suggested prices, but its printers are priced competitively with—and often a bit lower than—other units in their class.

The Dynax DX-15 printer uses a 96-character print wheel with a rated life of up to 10 million characters. It prints bidirectionally and with logic-seeking circuitry, and it offers automatic underlining; boldface printing; superscript and subscript printing; and proportional spacing. It is equipped with both a Centronics-style parallel interface and an RS-232C serial interface. Available options include a tractor-feed attachment, an automatic single-sheet feeder, and a detached keyboard. It measures 18 inches wide by 6½ inches high by 13 inches deep, and it weighs 19½ pounds.

The Brother HR-25 printer also uses a 96-petal daisy wheel with a lifetime rated at 10 million characters, and it offers the same range of features as the Dynax DX-15, plus a 3K expandable buffer memory. It measures 21 inches wide by 7½ inches high by 15 inches deep, and it weighs 30 pounds.

Dynax, Inc., prices vary

EPSON FX-80

Not many people can draw a perfect circle—but the Epson FX-80 dot-matrix printer can. The FX-80 has fully dot-addressable graphics and its print-head is precision-engineered to print in exactly the same scale vertically and horizontally. Because of this one-to-one graphics ratio, the FX-80 can print graphics drawn perfectly to scale—including pie charts that are real circles, and high-resolution drawings that look the same on paper as they do on the computer screen. The FX-80's accurate graphics make it especially well-suited for math, engineering, and business graphics applications.

The Epson FX-80 has 128 built-in type styles, plus 2K of built-in RAM that can be used either to store a user-designed character set or as a printer buffer that can come in especially handy during complex printing jobs. The FX-prints 9-dot by 9-dot characters with full descenders and four printing densities: normal, emphasized, bold, and double-emphasized. The printer can be used with pin-feed, roll, or single-sheet paper.

One especially useful feature of the FX-80 is a short-form tear-off bar that can be used to remove documents from the printer one inch below the last printed line. This bar is especially useful when the printer is used for printing checks and other kinds of preprinted forms.

The FX-80 is capable of proportional spacing, and can be used with a standard parallel interface.

Serial and IEEE-488 interfaces can be added as options.

Epson, \$699

EPSON FX-100

A moderately priced, high-speed dot-matrix printer bearing the famous Epson name: that's what you get when you buy the model FX-100, one of the newest printers in the Epson line. The FX-100 offers a wide range of print features, including a choice of elite or pica spacing. The printer also features a one-to-one graphics ratio so that you can create high-resolution graphics, including circles, and print them out on paper in accurate proportions. And the FX-100, like many other Epson printers, offers you the ability to create your own character fonts and download them into the printer's memory.

By keeping the design of the FX-100 simple, Epson has increased its reliability as well as decreased its cost. The unit is equipped with a rubber platen that can handle either single-sheet or roller-feed paper, and you can add a removeable tractor—which comes with the printer as standard equipment—to handle pin-fed paper and fanfold forms.

Epson FX-100, \$895

EPSON LQ-1500

The "LQ" in the model number of the Epson stands for "letter-quality"—and, although the LQ-1500 is a dot-matrix printer, it really does produce copy that's almost indistinguishable from that of a topnotch daisy-wheel model.

The LQ-1500 has a 24-pin printhead with three printing modes: draft, graphics, and letter quality. Its print quality is much better than that of most "correspondence-quality" dot-matrix printers, and it runs at 200 characters per second—about 3 times as fast as an average daisy-wheel printer.

Standard features of the Epson LQ-1500 include a single-sheet feeder; multiple character fonts; logic-seeking, bidirectional printing; and interfaceability with serial, parallel and IEEE communications ports. Options available with the printer include tractor and single-sheet feeders.

Epson LQ-1500, \$1,200 to \$1,500

FUJITSU PRINTERS

Fujitsu, one of the largest computer manufacturers in Japan, now has four personal computer printers on the market in this country—including

the fastest daisy-wheel printer that any manufacturer has offered to date, and a plain-paper thermal printer so outstanding that it could give thermal printers a good name. The other two Fujitsu printers being offered in this country are dot-matrix models that can turn out work of almost daisy-wheel quality. All four Fujitsu printers have many other special features, too.

The DPL24 is a dot-matrix printer, but it has a specially designed 25-wire print head and can produce text that is virtually indistinguishable from copy printed by a high-quality dot-matrix printer. The DPL24 can print 100 characters per second in its letter-quality mode, and can also be used in two other modes: a 200-cps correspondence-quality mode, and a 240-cps data processing mode. The printer's built-in character set includes the 96 standard ASCII characters, plus several European alphabets. And, because of its extraordinarily high character resolution, the DLP24 can also print custom-designed characters—even complex characters such as those used in the Japanese, Chinese, Arabic and Korean languages.

Other advanced features of the Fujitsu DPL24 include logic-seeking, bidirectional printing; horizontal and vertical tabulation; and high-speed form printing. The printer comes with a built-in Centronics-type parallel interface, and an optional serial interface is available. A tractor-feed mechanism is built in, and an automatic single-sheet feeder is optional.

Fujitsu says that its SP830 is the fastest daisy-wheel printer on the market. And speed is not its only attribute. Thanks to an advanced two-motor servo mechanism, a high-speed hammer and printing mechanism that's precision-engineered throughout, the SP830 prints extraordinarily clear, sharp, well-formed characters in up to six copies.

The SP830 prints at 80 characters per second, and can be used with 96-character and 127-character print wheels, for an unusually wide selection of type fonts. And it offers ultra-precise line and column spacing—adjustable to as little as 0.2 millimeters—for the precision printing of superscripts, subscripts, curves, and other graphics.

The Fujitsu SP830 is available with Centronics and RS-232C connectors as well as with a variety of other interfaces. A friction-feed platen is standard, and a bidirectional tractor feed and an automatic sheet feeder are available as options.

Fujitsu's Model SP320 is a high-quality, medium-speed daisy-wheel printer. It is compatible with 96-character and 127-character plastic and metal type wheels, making a wide variety of type styles available. Its carriage motor uses highly advanced con-

trol circuitry for precise positioning, and it has a lightweight hammer and an adjustable impact intensity that ensure crisp, clear printouts on up to six copies. The SP320 operates at speeds of 38 and 48 characters per inch, and is available with a wide variety of interfaces that make it compatible with almost all home and business microcomputers. A friction-feed platen is standard, and tractor and automatic single-sheet feeders are optional.

The fourth printer in the Fujitsu line, the TTP16, is an exceptionally high-quality thermal printer. It prints on plain paper and is capable of turning out documents that are sharper and clearer than most dot-matrix impact printers are capable of producing. The TTP16 actually is, amazingly enough, a near-letter-quality thermal printer.

The TTP16 is unusual in several other ways, too; it has a horizontal slot in front and when you lightly push a sheet of paper into the slot, a motor inside the printer will gently grasp the paper and pull it through. The TTP16 will then do its work—very quietly, since it is a thermal printer—and the printed page will be ejected upright through a slot in the top of the printer. You can then remove the page from a wire support that is built into the top of the printer—and, if the job you're doing calls for it, insert the next page.

The Fujitsu TTP16 prints 30 characters per second in either Courier 10 or Prestige Elite type. Its built-in character set includes the standard 96 ASCII character, plus European character fonts. And, when a ribbon is installed, it can be used as an impact printer. Black, yellow, magenta and cyan ribbons are available.

Fujitsu, DPL24 \$1,940; SP830 \$2,950; SP320 \$1,499; TTP16 \$625

INFOSCRIBE PRINTERS

"No matter which of our printers you buy," declares the Infoscrite Company of Santa Ana, California, "you still get nothing." What this means, the manufacturer quickly adds, is that when you buy an Infoscrite dot-matrix printer, you don't get anything you don't need. "The six printers in our Nothing Series offer a simplicity of design so uncluttered," the company explains, "that you may wonder what makes them run. And run. And run."

The features that Infoscrite printers do offer include fast printing, with bidirectional, logic-seeking action and speeds of up to 200 characters per second; adjustable pitch; both serial and parallel interfacing capabilities; and microprocessor-controlled electronics.

In addition, Infoscrite's printers have multiple

print modes. The three least expensive models in the company's line can produce either draft-quality or correspondence-quality printing, and the top three printers in the line have three printing modes: they can produce data-processing, correspondence-quality, and near-letter-quality printing.

The six printers manufactured by Infoscrite are:

- The Model 500 DataScribe, a draft-quality/correspondence-quality printer with a top printing speed of 150 characters per second. The DataScribe has a 9-wire print head and two resident 96-character fonts.
- The Model 700 DocuScribe, another draft-quality/correspondence-quality model with a maximum speed of 150 characters per second. The DocuScribe also has a 9-wire print head and two resident 96-character fonts.
- The Model 1000 TextScribe, a draft-quality/correspondence-quality printer with a top operating speed of 200 characters per second. The TextScribe is equipped with a 9-wire print head and two resident 96-character fonts, and can also print high-resolution dot graphics.
- The Model 1100 LetterScribe, a near-letter-quality, draft-quality and correspondence-quality unit with a maximum speed of 200 characters per second. The LetterScribe has a 9-wire print head and two resident 96-character fonts, and can also be used with downloadable character fonts and high-resolution dot graphics.
- The Model 1200 ColorScribe, an eight-color printer with draft-quality, correspondence-quality and near-letter-quality printing modes. The ColorScribe has a 90-wire print head and a top operating speed of 200 characters per second. It has two 96-character type fonts built in, and can also be used with downloadable fonts and high-resolution, dot-addressable color graphics.
- The Model 1400 MultiScribe, a near-letter-quality printer with proportional spacing and a maximum operating speed of 200 characters per second. The MultiScribe has an 18-wire print head that can produce fully formed 24-dot by 18-dot characters at a speed of 80 characters per second. It has two resident 96-character fonts, plus downloadable-font and ultra-high-resolution graphics capabilities.

Infoscrite Co., Model 500 DataScribe \$830; Model 700 DocuScribe \$1,160; Model 1000 TextScribe \$985; Model 1100 LetterScribe \$1,798; Model 1200 ColorScribe \$1,995; Model 1400 MultiScribe \$1,995

THE JUKI 6100

Juki has one industry about sewed up, and has

now plunged into another. Juki, one of the world's largest manufacturers of computerized sewing equipment, has unveiled its first computer printer: the Model 6100, a daisy-wheel unit with a price that the average personal computer owner can afford. The unit prints at a fairly rapid speed of 18 characters per second, and has a host of special features.

The Juki 6100 can be used with Triumph-Adler and Royal print wheels and with a standard IBM Selectric ribbon. And it has a drop-in daisy wheel print system that eliminates the hassle from changing type fonts. The 6100 prints bidirectionally, and supports word-processing functions such as bold and shadow printing, double-strike, underlining, superscript and subscript characters, and graphics characters. And it is compatible with a wide variety of personal computers, including Apple computers, Radio Shack computers, Commodore computers, and the IBM PC.

The Model 6100 has a 2K buffer memory, expandable to 8K. It is equipped with logic-seeking capabilities and with a self-testing program. Other features include a linear induction motor for accurate positioning, a low noise level (rated at 62 dB), and a standard Centronics-style parallel interface. Available options include an RS-232 serial interface, a memory-expansion chip, a bidirectional tractor feeder, and an automatic single-sheet feeder. Without the optional feeders, the Juki 6100 will print on single-sheet paper up to 13 inches wide, but the paper must be hand-fed.

Juki 6100, \$599

MANNESMANN TALLY PRINTERS

Mannesmann Tally, a company in Kent, Washington, is one of the world's leading manufacturers of computer printers—and when you've worked for a while with a Mannesmann Tally printer, it isn't difficult to understand why. MT specializes in making ruggedly built, industrial-quality printers designed to be operated around the clock without slowing down. And some of MT's best dot-matrix units produce such high-quality work that it's almost identical to copy generated by a top-quality daisy-wheel model.

Two of Mannesmann Tally's most popular lines of printers are the MT-160/180 series and the MT-1600/1800 family.

The least expensive printer in these two series is the MT-160 I, an 80-column model. The MT-160 I prints at 160 characters per second, bidirectionally and with logic-seeking capabilities for fast printing of short lines. The MT-160 I can be ordered with either a standard parallel connector or a standard

RS-232C serial connector. And the printer is compact, too; it measures only 13.7 inches wide, 9.64 inches deep, and 6.2 inches high, and it weighs less than 17 pounds.

The Mannesmann Tally MT-160 L has all of the features of the MT-160 I, plus a letter-quality print mode; proportional spacing; automatic right and left margin justification; and automatic centering. In its letter-quality mode, the MT-160 L prints characters in a 20-dot by 18-dot matrix at a speed of 40 characters per second. Printing density ranges from 20 characters per inch in a condensed format to 5 characters per inch in an extra-wide mode.

The Model MT-160 L has a standard 96-character ASCII character set, plus a set of 96 letter-quality characters and six foreign-language character sets. In addition, 11 graphic symbols and 31 scientific characters are provided.

The MT-160 L, like the MT-160 I, is available with a parallel or a serial interface. And its measurements are the same.

The Mannesmann Tally 160 L and 160 I are equipped with a tractor-feed mechanism that can be used with single-sheet paper. To configure the printers for use with roll or fanfold paper, optional attachments are required.

There are four printers in the Mannesmann Tally MT-1600/MT-1800 series: the MT-1602 and MT-1605, and the MT-1802 and MT-1805.

The MT-1602 is a data-processing printer with an ultrafast printing speed of 200 characters per second. It accepts paper up to 15¼ inches wide, and has a line width of up to 218 columns. Print sizes range from 16½ characters per inch (condensed) to 5 characters per inch (extra-wide), with vertical spacing of either 6 or 8 lines per inch. The MT-1602 is equipped with a standard Centronics-type parallel interface and a one-line print buffer.

The Model MT-1605 is similar to the MT-1602, but is equipped with an RS-232C serial interface and a 2,000-character buffer.

Mannesmann Tally's MT-1802 is a parallel-interface printer with the same features as the MT-1602, plus a number of others. Its additional features include two selectable letter-quality type fonts, a special "quietized" cabinet, and quad-density graphics capabilities.

The MT-1805 has the same features as the MT-1802, but is a serial-interface printer.

Optional accessories for Mannesmann Tally's MT-1600/1800 series printers include a printer stand with an output stacker, a paper basket for desktop use, a paper separator, a quick-tear kit for printing short forms, a hush-tone kit for 1600-series units, and additional character fonts.

Mannesmann Tally, MT-160 I \$698; MT-160 L \$798; MT-1602 and -1605 \$1,695; MT-1802 and -1805 \$1,995

MICRO PERIPHERALS

And now for something completely different: a line of dot-matrix printers totally unlike anything else on the market. They're called the PrintMate 99, the PrintMate 150, and the Sprinter; and they're all manufactured by Micro Peripherals, Inc., of Salt Lake City, Utah.

The PrintMate 99 is a two-mode text-and-graphics printer that zips along at a top speed of 100 characters per second with the help of bidirectional operation and microprocessor-controlled logic circuitry. The printer has two built-in ASCII character sets: an 11-dot by 9-dot set for correspondence-quality printing, and a 7-dot by 9-dot set for high-speed draft printing and data processing. Type density ranges from five to 17 characters per inch. The PrintMate 99 can also print high-resolution dot-addressable graphics with a vertical resolution of 72 dots per inch.

The PrintMate 99 has both a friction-feed platen and a built-in tractor-feed, so it can print on either single-sheet or pin-fed fanfold paper up to 8½ inches wide. And it also has an unusual single-sheet feeder mechanism. The printer has a front slot into which a single sheet of paper can be inserted; then, when printing is completed, the paper can simply be removed from the printer, in the same way that a piece of typing paper is removed from a typewriter. The PrintMate 99 thus makes single-sheet printing about as simple as it possibly could be.

Another special feature of the PrintMate printer is a 1K print buffer that is optionally expandable to 2K. Another extra-cost option is an "AP-PAK" applications package that can increase the printer's graphics capabilities. With an AP-PAK, you can create your own special characters and graphics, and can use several additional type fonts. You can also use the AP-PAK to print graphs and charts on the PrintMate using simple commands.

The MPI PrintMate 99 comes with both a Centronics-style parallel interface and an RS-232 serial interface, and is plug-compatible with most popular microcomputers. Other types of interfaces are optionally available.

The PrintMate 99 is an attractive printer with an unusual design. During the printing process, the page that is being printed stands up at a sharp angle behind an almost vertical smoked-plastic cover, and can therefore be read quite easily. This

feature, along with the front-panel slot that is used for single-sheet feeding, combine to give the PrintMate 99 an appearance that is as unusual as its many special features are.

Another dot-matrix printer from MPI, the PrintMate 150, is a wide-carriage model that can print lines up to 13 inches long on paper up to 15 inches wide. Its printing rate is 150 characters per second, and a high-speed space skip ensures a high printing speed over short lines. The PrintMate 150, like the PrintMate 99, is a dual-mode unit with an 11-dot by 9-dot correspondence-quality font as well as a 7-dot by 9-dot draft and data-processing font. Custom character sets can also be downloaded.

Print density ranges from 15 to 17 characters per inch in text mode, and there is also an ultra-high resolution graphics mode that provides up to 6,120 individually addressable dots per square inch. For even more versatile graphics programming, the PrintMate 150—like the PrintMate 99—can be used with MPI's AP-PAK graphics software.

The MPI PrintMate 150 is equipped with a Centronics-style parallel interface, and comes with a cable that is compatible with the IBM Personal Computer. An RS-232C serial interface is optionally available. The printer is designed to be used with fanfold paper, and comes equipped with a built-in adjustable tractor-feed.

The PrintMate 150 comes in two versions. In its most basic configuration, the printer is designated the Model 150 B. A more deluxe model, the 150 A, has all of the features of the 150 B, plus a "Softswitch" programmable keypad. The Softswitch pad, similar in appearance to the dial of a pushbutton telephone, can be used to program certain printing features, such as form length, print density, horizontal and vertical tabbing, baud rate (for serial-interface printing) and character set.

The third printer manufactured by MPI is a portable model called the Sprinter. The Sprinter comes in a rugged, high-impact plastic carrying case that looks much like the carrying case of a portable electric typewriter. When it is in its case, the printer measures 18 inches wide by 14½ inches deep by 7 inches high, and weighs 16 pounds.

The Sprinter is a dual-mode printer with a printing speed of up to 160 characters per second. It prints 7-dot by 9-dot characters in its data-processing mode, and 11-dot by 9-dot characters in its correspondence-quality mode. Print density ranges from 10 to 17 characters per inch, and high-resolution dot-addressable graphics are also available. Like the other two printers in the MPI line, the Sprinter can be used with AP-PAK software for increased graphics capabilities.

The MPI Sprinter is equipped with a 4K print buffer, expandable to 68K. Like the PrintMate 99, it has both a built-in tractor-feed and a front-panel slot designated for the hand feeding of single-sheet paper. And, like the PrintMate 150 A, it has a front-panel "Softswitch" that can be used to select special printing features.

The Sprinter comes with a standard Centronics-type parallel interface, and with a cable that is compatible with the IBM Personal Computer. An RS-232C serial interface is available as an option.

Micro Peripherals, Inc., PrintMate 99 \$599; PrintMate 150 A \$1,150; PrintMate 150 B \$1,045; Sprinter \$695

THE NEC SPINWRITER 2050

No survey of personal computer printers would be complete without a mention of the NEC Spinwriter, one of the most popular printers in the short history of microcomputing.

The current Spinwriter, the Model 2050, is a dot-matrix unit that prints at a speed of 23 characters per second. Pitch is adjustable to 10, 12 or 15 character per inch, and platen width is 16 inches.

The NEC Spinwriter uses a thimble-shaped printing element rather than a daisy wheel or a type ball. And there are 128 characters on the element, compared with 96 on the petals of a conventional daisy wheel.

The Spinwriter comes with a plug-in interface module that can be changed to make the unit compatible with a wide variety of computers. Just open a door on the back of the printer, and you can unplug the interface and replace it with a different one. Now that's versatility!

The NEC Spinwriter is a rugged, solidly constructed printer that can take a lot of pounding for a long time without breaking down. According to NEC, the typical Spinwriter can print 40 million characters before it's maintenance time. And there are many Spinwriters out there that have been Spinwriting for a lot longer than that without breaking down.

NEC, \$1,225

OKIDATA PRINTERS

Okidata's broad line of dot-matrix printers is probably the most successful since Epson introduced its MX-80. For almost any combination of speed, print quality, and price, there is an Okidata printer.

The quality of which Okidata seems proudest, however, is durability. The firm quotes two seldom-

seen figures in most of its product literature—mean time before failure (MTBF) and mean time to repair (MTTR). Okidata rates the MTBF of its printers at 2,200 hours for its top-of-the-line Pacemark models and 4,000 hours for the rest of its models. The MTTR for all is quoted at 45 minutes.

There are two basic varieties of Okidata printer: the Microline series and the Pacemark series. There are six Microlines, with list prices ranging from \$400 to \$1,400. The Pacemark line includes the 2350 model, with a suggested retail price of \$2,700, and the 2410, at \$3,000.

The lowest-priced Okidata printer is the \$400 Microline 80. It prints unidirectionally at 80 characters per second and can place 80 columns of standard-width characters on paper up to 8.5 inches wide. Using a 7-pin print head, it can generate all 96 standard ASCII characters and 64 special graphics symbols. It has a tractor feed for fanfold paper and will also accept single sheets. The Microline 80 uses a standard Centronics-type parallel connector.

One step up is the Microline 82A, which comes equipped with both a parallel and a serial interface and is priced at \$500. The Model 82A prints bidirectionally at a speed of 120 characters per second, using time-saving line-seeking logic. It has a 9-pin print head that gives more readable output than the 80. Like the Model 80, it can produce all 96 standard ASCII characters and 64 graphics characters, and accepts standard 8.5-inch fanfold paper or cut sheets.

The Microline 83A is a 136-column, wide-paper version of the Microline 82A. Its specifications are similar to those of the 82A. The suggested retail price is \$750.

The three other printers in the Microline series—the 92, the 93, and the 84—offer correspondence-quality printing that looks reasonably like the work of a high-quality daisy-wheel printer. You will not ever mistake their output for that of a daisy wheel, but the quality is high enough for all but the most formal communications. All three units come with both parallel and serial connectors. All can print both built-in and downloadable character sets as well as dot-addressable graphics.

The Okidata Microline 92 can print standard dot-matrix characters at a speed of 160 characters per second and correspondence-quality documents at 40. It accepts 8.5-inch-wide pin-fed and single-sheet paper, and an optional automatic sheet feeder is available. It sells for a suggested retail price of \$600. With typical discounts, it is Okidata's most direct competitor for the Epson MX-80. The print quality is slightly better than the Epson's, and it has the advantage of accepting ordinary type-

writer ribbons instead of costly and hard-to-find cartridges.

The Microline 93 has all the features of the Model 92. It is a 136-column, wide-paper printer, with a suggested price tag of \$1,000.

The Microline 84 is another 136-column printer. Faster than the Model 93, it is also more expensive. The Model 84 can print standard characters at 200 characters per second and correspondence-quality characters at 50 cps. It retails for \$1,400.

The Okidata Pacemark 2350, a lower-priced printer in this line, is a data-processing unit that operates at a speed of 350 characters per second. It can print up to 136 columns of standard-width characters on paper up to 16 inches wide. It offers both the standard 96-character ASCII set and an alternate 96-character set; it can also handle a downloadable character set and dot-addressable graphics. It comes with both a parallel and a serial interface, and its suggested retail price is \$2,695.

At the top of the line is the Pacemark 2410. It prints correspondence-quality documents at 80 characters per second and turns out draft-quality material at 350 characters per second. It can print in two colors on paper up to 16 inches wide. The Pacemark 2410's suggested retail price is \$3,000.

PANASONIC PRINTERS

Panasonic, one of Japan's largest manufacturers of household appliances and consumer electronics products, has plunged into the computer printer market with six new models: four dot-matrix printers and two printer-plotters.

Two of Panasonic's new printers—the KX-P1092 and the KX-P1093—are nine-pin units that print bidirectionally, with logic-seeking circuitry to speed up the printing of short lines. The P1092 has three print modes: one for data processing, one for graphics printing, and one for correspondence quality (almost letter-quality) printing. The KX-P1092 has a top printing speed of 180 characters per second, in either pica or elite, and uses an endless cartridge-type ribbon that is equipped with an ink reservoir for long life. The printer is equipped with both friction-feed capability and a tractor-feed mechanism. A Centronics-type parallel interface is standard, and an RS-232C serial interface is optionally available.

The Panasonic KX-P1093 features the same three print modes that are available with the KX-P1092. But the P1093 has a top printing speed of 160 characters per inch, has a removable tractor-feed attachment, and includes special facilities for bulk paper loading and label printing. It is available with

either a parallel or a serial interface. And it can accommodate paper up to 15 inches wide.

Panasonic's two other dot-matrix printers are the KX-P1090 and the KX-P1160.

The KX-P1090 is a bidirectional text-and-graphics printer with a top speed of 96 characters per second and a maximum line width of 159 characters. The printer has a built-in tractor-feed mechanism as well as a friction roller, so it can accommodate both fanfold and single-sheet paper. A parallel interface is standard, and a serial interface is optional.

The KX-P1160 is a bidirectional printer with a logic-seeking print mechanism and a maximum operating speed of 196 characters per second. It prints 9-dot by 16-dot characters with descenders, and it has an adjustable tractor-feed that is capable of handling fanfold paper from 4 inches to 15 inches wide. An optional front inserter is available for single-sheet printing.

The P1160 printer features microprocessor-controlled line spacing for automatically incremental positioning of characters both upward and downward on the printed page. The P1160 can be purchased with either a parallel interface, which is standard, or a serial interface, which is optional.

The two new Panasonic printer-plotters are the Model VP-6801P and the Model VP-6802P. Both of these units have a wide range of professional and business-oriented applications, such as the production of graphs, charts, diagrams, and computer-generated graphics.

The VP-6801P is equipped with six drawing pens that can produce six-color drawings over a plotting area that measures 10 by 7.2 inches. Writing speed is 16 inches per second. The VP-6801P has an ASCII 8-bit parallel interface, and both RS-232C and GP-IB interfaces are optionally available.

The VP-6802P plotter uses eight pens and has a drawing speed of 18 inches per second. Its drawing surface measures 14 by 10.2 inches, and it has an electrostatic paper-holding mechanism to keep the paper motionless and ensure accuracy.

The 6802P plotter is also equipped with a number of "intelligent" functions designed to simplify the creation of complex graphics. For example, it can print in italics, and can respond to rotation, circle, and zoom commands.

Panasonic, KX-P1092 \$599; KX-P1093 \$899; KX-P1090 \$499; KX-P1160 \$1,550; VP-6801P \$1,565; VP-2802P \$3,200

PR 2300 JET-SPRAY PRINTER

The PR 2300 is a high-tech marvel: It uses a spark-ink-jet mechanism to shoot dot-matrix char-

acters quickly and silently onto a page. Anyone who has suffered through the noisy clunking of an impact-type printer will appreciate the 101. It is a small, lightweight (11½ pounds) clean-looking machine with just three buttons, four indicator LEDs, and a beeper that sounds off upon initialization and whenever the printer receives an erroneous code. It features bi-directional printing and can handle both continuous form and paper rolls with equal facility.

Characters—made with a seven-by-seven matrix—are not as sharp as those on many of the best conventional dot-matrix printers; the individual dots are fuzzy, and they often wander slightly out of position. But the 2300 can print double-height, double-width characters with single underscores, dashed underscores, or double underscores. In addition, it can print 10, 12, or 18 characters per inch, and it allows you to vary the vertical line spacing from a single space up to a nine-line space. Though it does not support boldface or italics, the 101 can produce 8 sets of 96 characters: U.S./ASCII, German, Spanish, French, Italian, Swedish/Finnish, English (Great Britain), and International.

The PR 2300 boasts a print speed of 50 lines per minute. That's approximately 65 characters per second. It can also spin out spectacular graphics effects of 880 dots per line, or 110 dots per inch. Its graphics are further enhanced by a Zoom command, which doubles each dot in the image, and a Reverse command, which creates a negative image. Graphics speed is a brisk 25 lines per minute.

On the technical side, the 2300 takes either the Centronics 8-bit parallel interface or the RS-232-C or current loop serial interfaces. The printer has a line buffer that holds about 1,000 characters. All its print functions are controlled by a one-chip microprocessor, which bodes well for repairs.

About the only feature that the PR 2300 could use would be a paper roller that you could turn by hand to back up a sheet or part of a sheet of paper, but this is a minor quibble. This is a reliable unit that does its job well. If you can tolerate the print quality, it's a bargain.

Compatibility: Both serial and parallel port versions available.
Olivetti, \$409

PRACTICAL AUTOMATION PRINTERS

Practical Automation, a company that manufactures heavy-duty computer printing equipment, now offers two workhorse computer printers: rugged, ultra-fast units that are designed and built to stand up under sustained use in demanding envi-

ronments. And, considering their durability and high quality, the prices of Practical Automation printers are relatively modest.

The printers are the 8-PLP, an 80-column model that operates at 275 characters per second, and the 15-PLP, a 132-column unit that runs at the same high speed. Both printers are available with either standard Centronics-style parallel interfaces or standard RS-232 serial interfaces.

Both Practical Automation printers use a heavy-duty head that is equipped with nine tungsten needles and operate in an ultra-fast "free-flight" mode. And the printers are available with print buffers ranging in capacity from 8K to 32K. This feature can free your computer for other work while documents—even long reports and manuscripts—are being printed.

Even the ribbon that is supplied with the 8-PLP and the 15-PLP is designed for heavy-duty use. The printers use a stationary ribbon cartridge which, according to Practical Automation, contains three times the fabric used by competitive printers. "This translates into being able to run the 8-PLP and the 15-PLP not until the ribbon shreds," declares the manufacturer, "but until the paper is exhausted—and beyond."

The 8-PLP and the 15-PLP can print both text and dot-addressable graphics, bidirectionally and with automatic margin-seeking. The printers have two 96-character fonts—and a standard ASCII character set and a European/match character set—built into a removable EPROM. And all basic control functions used by the two printers are provided on modular plug-in boards. Separate boards are provided for the printer controller, the driver, the filter, and the power supply. This modular construction simplifies troubleshooting and can reduce maintenance costs.

Practical Automation, 8-PLP \$728-\$930; 15-PLP less than \$1,000

THE PRIMAGE I PRINTER

The Primage I, manufactured by Primages, Inc., of Bohemia, New York, is a letter-quality daisy-wheel printer that operates at 45 characters per second but is priced competitively with most 20-cps machines.

According to its manufacturer, the secret behind the Primage I's high speed and moderate price is "a patented control technology which enables low-cost, commercially available stepping motors to drive the printer with the speed and precision of more expensive servo motor drives. As a result," the company explains, "the new printer achieves the speed and performance of servo-driven ma-

chines, but uses less expensive components and subsystems."

The Primage I uses a 100-spoke daisy wheel that can be used to print special characters and the special accents required by foreign alphabets, as well as the standard ASCII character set, which has 96 characters. Printing pitch can be adjusted to 10, 12 or 15 characters per inch, with proportional spacing. The printer can accept paper up to 14 inches wide.

The Primage I is available with either a Centronics-style parallel interface or an RS-232 serial interface. The printer can print on single-sheet or fanfold paper, but optional accessories are required for automatic feeding. A tractor-feed mechanism can be purchased separately, and an automatic sheet feeder is also available.

Primages, Inc., \$1,995; tractor-feed mechanism \$275

QUADJET QJ9000 COLOR PRINTERS

The Quadjet QJ9000 Color Printer contains two cartridges (black and color) which allow it to print in seven colors: yellow, blue, red, green, cyan, magenta, and black. It is able to print on either roll paper or cut sheets. The roll paper seemed to give the best results and, as both this unit and Radio Shack's color ink jet printer are based on a Canon printer mechanism, the roll paper is readily available at most local Radio Shacks, as are the ink cartridges (which are good for approximately 8 rolls of paper or 4 million characters).

Setting up this printer is easy. Unpack the unit, load some paper, plug in a parallel cable, turn the unit on, unlock the carriage (which also uncaps the print nozzles), and go. The process takes almost as long to describe as to perform.

The QJ9000 comes with software to allow you to perform color screen dumps. *QJET1* dumps the color screen as it appears, while *QJET2* lets you switch around colors on the dump. The Quadjet prints at a top speed of 37 cps, so a screen print can take several minutes.

The QJ9000 can text, although its 5 X 7 matrix and lack of lower-case descenders will most likely make it impractical for use as your only printer, especially if you do much word processing.

The Quadjet QJ9000 is one of the first of a new breed, the inexpensive color printer. While slow, it provides a practical way of generating color hard copy. Unfortunately, almost no software configured to be used with the Quadjet is available right now. Quadram intends, though, to provide software which will emulate the IDS Prism color printer. If you write most of your own graphics pro-

grams, you should have no difficulty configuring them to take full advantage of the QJ9000.

Quadram Corporation, \$699

THE SANYO PR 5000 AND PR 5500

Sanyo offers two highly affordable daisy-wheel printers: the PR 5000 and the PR 5500.

The Sanyo PR 5000 prints at a speed of 14 characters per second, bidirectionally and with logic-seeking circuitry for the fast printing of short lines. Printing pitch is adjustable from 10 to 15 characters per inch. The PR 5000 can handle paper up to 12½ inches wide, and is designed to print on single-sheet paper using a friction-feed platen.

The PR 5000 is equipped with a standard Centronics-style parallel interface, and it has convenient front-panel switches for line-feed, form-feed, and top-of-page functions, as well as a switch to put the printer on line.

The Sanyo PR 5500 can print 16 characters per second at a pitch of 10, 12, or 15 cpi. It will accept paper up to 17 inches wide, and has a maximum printing line of 13.2 inches. The PR 5500, like the PR 5000, is a friction-feed printer. But an optional tractor-feed mechanism for the PR 5500 is available.

Both the PR 5000 and the PR 5500 use a 96-character print wheel that comes in a number of sizes and type styles. Foreign-language and special purpose print wheels are also available.

Sanyo, PR-5000 \$595; PR-5500 \$995

SIEMENS INK-JET PRINTERS

A lot has been written lately about ink-jet printers, and that is not surprising. Ink-jet printers, which squirt ink onto a page instead of pounding it into place with a print head, are almost completely silent and can print at speeds approaching 300 characters per second. And one of the pioneers in ink-jet printing technology is Siemens Communications Systems of Boca Raton, Florida.

One of the first ink-jet printers on the market was the Siemens PT 80, which had a price tag of \$3,225. Fortunately, the price of ink-jet printers is now coming down, and Siemens now has three new units: the Model 2712, the PT 88, and the PT 89. The company is leaving the exact prices of its new units up to its retailers, but promises that they will be considerably lower than the price that the PT 80 originally sold for.

The Siemens 2712 is equipped with 12 ink jets, arranged in two rows, and can print 12-dot by 9-dot characters at a speed of 270 characters per sec-

ond. The jets never touch the paper, so there's no print head to wear out. They can get clogged up with ink, though, so you have to keep them clean.

The printer can produce both text and dot-addressable high-resolution graphics. Its print quality is about the same as that of a very high-quality impact-style dot-matrix printer.

The ink used in the Model 2712—as in all Siemens printers—dries on contact with the paper and doesn't run or smear. The ink is kept in an easily changeable container, and an estimated five million characters can be printed before the ink has to be replenished.

The Siemens 2712 has a builtin set of 128 characters, including graphics characters, special characters, and foreign-language characters. Type density ranges from 5 to 16.25 characters per inch. The 2712 can print on a single-sheet, roll or fanfold paper up to 8½ inches wide. Both a Centronics-style parallel interface and an RS-232C serial interface are provided.

Siemens Communications Systems, price varies

SMITH-CORONA PRINTERS

Smith-Corona, which has been making typewriters for about as long as anyone can remember, plunged into the computer-printer market a couple of years ago with the introduction of a low-priced daisy-wheel model called the TP-1. Now Smith-Corona has a brand new daisy-wheel printer called the TP-II Plus, and has also unveiled three new dot-matrix printers.

The Smith-Corona TP-II Plus is a letter-quality printer featuring both multiple-pitch capability and bidirectional printing. It runs quieter than its predecessor, the TP-I, and offers many more features.

The TP-II Plus prints 12 characters per second, bidirectionally and using logic-seeking circuitry. It has a convenient front-panel switch for adjusting pitch to 10, 12 or 15 characters per inch. It can handle paper up to 13 inches wide, and can print up to 157 characters per line. Paper must be hand-fed, unless an optional tractor-feed attachment is purchased.

Line spacing is adjustable on the TP-II, to 3, 4½, or 5 lines per inch. And the printer comes with two built-in interfaces: a standard Centronics-style parallel interface, and a standard RS-232C serial connector.

The dot-matrix printers now offered by Smith-Corona are the top-of-the-line D-300, which prints at 140 characters per second; the D-200, which has a printing speed of 120 cps; and the D-100, which prints at 100 cps.

The Smith-Corona D-300 has two printing modes: a standard mode that produces 9-dot by 8-dot characters, and an NLQ ("near letter-quality") mode that prints exceptionally high-quality 17-dot by 16-dot characters. The D-300 prints both text and bit-image graphics, and it offers a choice of six foreign language fonts and six pitches, as well as proportional spacing, an italics character set, superscript and subscript characters, and a choice of emphasized or extra-wide printing.

The D-300 prints bidirectionally, with electronic logic-seeking, and it provides both horizontal and vertical tabbing. Both friction feed and tractor feed are standard, and so are dual interfaces: one serial and one parallel. The D-300 also has built-in self-test circuitry.

The Model D-200 also features both a standard printing mode and an NLQ mode that produces 17-dot by 16-dot characters. Other features of the D-100 include proportional spacing; an italics character set; a choice of six pitches; standard, emphasized or extra-wide printing; a 2K print buffer; and character sets that provide printing in six foreign languages.

The D-100 offers six pitches, six foreign language character sets, and both friction-and tractor-feed capabilities. A parallel interface port is standard, and a serial interface is optional.

Smith-Corona TP-II, \$645; Optional Tractor-feed Attachment \$149; Smith-Corona D-300 \$795; Smith-Corona D-200 \$595; Smith-Corona D-100 \$395

STAR MICRONICS PRINTERS

What this country needs is a good line of inexpensive computer printers. That's how the folks at Star Micronics felt when they went into the printer business, and it's still how they feel today. Star Micronics now has a broad line of good-looking, full-featured printers that are about as easy on the budget as any printers around.

Star Micronics' most affordable printer is the STX-80, an 80-column thermal unit that can print text and dot-addressable high-resolution graphics on heat-sensitive roll paper up to 8½ inches wide. The STX-80 has a big built-in character set containing 96 ASCII characters, 51 European characters and 64 block characters, and is capable of printing both normal and extra-wide characters.

There are six dot-matrix impact printers in the Star Micronics line: The Gemini-10X, the Gemini-15X, the Delta-10, and the Delta-15, the Radix-10, and the Radix-15.

The G-10X can print text and both low- and high-

resolution graphics at a rate of 120 characters per second. Print sizes range from 8.5 to 17 characters per inch. The printer has an 816-character print buffer, and can print boldface, italic, superscript and subscript characters. It comes with a standard parallel interface, and an RS-232C serial interface is optionally available. It can print on single-sheet, fanfold or roll paper up to 10 inches wide.

The Gemini-15X printer is similar to the G-10X, but can handle paper up to 15 inches wide.

The Star Micronics Delta-10 is a 160-CPS dot-matrix unit with print sizes ranging from 8.5 to 17 characters per inch. It can print 96 standard ASCII characters and 96 italic characters, plus 64 special characters and 88 international characters. Its character set also includes 32 block characters, and it supports user-defined characters and both high-resolution and low-resolution bit-mapped graphics. The Delta-10 is capable of printing normal, elite and condensed characters, as well as underlined characters, boldface and enlarged characters, superscripts, and subscripts. It can handle single-sheet, fanfold or roll paper up to 10 inches wide, and it has both a serial interface and a parallel interface for easy connection to almost any computer.

The Delta-15 printer from Star Micronics is similar to the Delta-10, but can print on paper up to 15 inches wide.

The most expensive dot-matrix printers offered by Star Micronics are the Radix-10, which can use paper up to 10 inches wide, and the Radix-15, which can print on 15-inch-wide paper. Most of the other specifications of the R-10 and the R-15 are identical. Both models use a nine-wire head capable of printing both monospaced and proportionally spaced characters that approach daisy-wheel print quality. Print sizes range from 8½ to 17 characters per inch, and print speed is 200 cps. The R-10 and R-15 offer even larger character sets and even more type fonts than those provided by Star Micronics Delta-10 and Delta-15 printers. And the R-series units are loaded with special features, including automatic single-sheet insertion, pause, and feed buttons, reverse paper feed, and 22 easy-access format switches. The R-10 and R-15 can print user-defined character sets, and are equipped with both Centronics-type parallel connectors and RS-232C serial connectors.

Star Micronics also manufactures a moderately priced daisy-wheel printer: the Powertype, which prints 18 characters per second. The Powertype uses a 96-petal type wheel, and more than 100 type fonts are available. It can print 10-pitch, 12-pitch and 15-pitch characters, with monospace or pro-

portional spacing. Special features include a dual (parallel and serial) interface, 32 easy-access format switches, reverse paper feed, a short-form tear-off, and a self-test diagnosis feature. The Powertype can print on single-sheet or roll paper up to 8½ inches wide. An optional tractor-feed accessory is required for printing on fanfold paper.

Star Micronics, STX-80 \$199; G-10X \$399; G-15X \$549; Delta-10 \$549; Radix-10 \$849; Radix-15 \$995; Powertype \$499

TANDY PRINTERS

Tandy Corporation, the parent company of Radio Shack, offers a comprehensive line of personal computer printers ranging from a \$99.95 thermal model all the way up to a \$2,000 dot-matrix unit capable of printing text that's totally indistinguishable from copy produced on a high-quality daisy-wheel printer.

Tandy's most economical printer is the TP-10, an ultracompact unit that measures just 3 inches-by-8 inches-by-5 inches. It can print 32 characters per line at a speed of 30 characters per second on 4⅛-inch-wide paper. It can print both text and graphics with whisper silence, and it has two special printing features: an elongation mode for expanded printing and a repeat function to make graphics programming easier. The TP-10 comes with a serial interface that's specially designed for use with the Radio Shack Color Computer line.

The most affordable impact printer offered by Tandy is the DMP-120 dot-matrix model. It can print standard and condensed text, as well as graphics characters, at 120 cps. In its text mode, the DMP-120 prints monospaced (not proportionally spaced) characters using a 9-dot by 8-dot matrix. Pitches ranging from 10 to 16.7 characters per inch can be switch-selected or software-controlled. The DMP-120 can print underlined and elongated characters, and can handle standard 8½-inch-wide single-sheet, fanfold or roll paper.

Tandy offers two daisy-wheel printers: the DWP-210 and the DWP-140. The DWP-210 can print either 10 or 12 characters per inch at a speed of over 200 words per second. Interchangeable drop-in daisy wheels, available separately, provide a wide variety of type styles. The printer comes equipped with a standard parallel interface, as well with a serial interface compatible with Radio Shack Color Computers. It can print on single-sheet or roll paper, but to make it work with pin-feed fanfold paper you'll need an optional bi-directional tractor-feed kit.

The Tandy DWP-140 daisy-wheel printer can

print either 10 or 12 characters per inch with proportional spacing, and at a speed of 300 characters per second. Other features of the DWP-140 include full-line and half-line paper feed; a programmable backspace; and an "Automatic Paper Set" function that makes paper loading a snap. To load a sheet of paper in the DWP-140, all you have to do is insert it behind the platen and pull an "Autoset" lever—and the job is done. The DWP-140 has a 15-inch platen, and comes with a standard parallel interface and one carbon ribbon cartridge.

The premiere printer in the Tandy line is the DMP-2100, a super-deluxe dot-matrix machine that has three printing modes. The DMP-2100 can be operated in a data-processing mode that runs at 160 characters per second, a high-resolution graphics mode that operates at 93 to 215 lines per minute, and a letter-quality mode that has a printing speed of 100 characters per second.

When the DWP-100 is operated in its letter-quality mode, the copy that it produces looks every bit as good as text printed on a top-quality daisy-wheel printer. The secret behind the DMP-100's print quality is a 24-wire head that can print 32,400 dots per square inch, providing ultra-sharp, fully formed letters in a single pass over the paper. Matrix sizes are 18 by 24 dots for standard letters and 36 by 24 dots for high-resolution monospaced letters.

The DMP-2100 character set includes 96 ASCII characters, 31 international characters and 31 special graphics characters. The printer offers bold-face and underlining functions, plus a variety of type styles, including standard, condensed, and high-resolution monospaced and proportionally spaced characters. Graphics can be printed using dot-addressable bit-mapping.

Optional equipment available for the DMP-2100 includes a bidirectional tractor-feed attachment and an automatic sheet-feeder attachment.

Tandy also offers a seven-color ink-jet printer, the CGP-200, that can print both text and graphics at a speed of 2,600 dots per second and with a resolution of 640 dots per line. In its text mode, the CGP-200 can print 12 characters per second. The characters have a resolution of 7 by 5 dots.

Tandy, TP-10 \$99.95; DMP-120 \$500; DWP-210 \$800; DWP-140 \$1,500; Bidirectional Tractor-feed Kit \$150; DMP-2100 \$2,000; CGP-220 \$699

TRANSTAR PRINTERS

Vivitar, a computer company based in Bellevue, Washington, has a constellation of personal computer printers that are sold under the brand name Transtar. Vivitar's line includes the Transtar 120, a

daisy-wheel printer that weighs just 19 pounds; two other daisy-wheel printers, the Transtar 130 and Transtar 140; and the Transtar 315, a low-cost color impact printer.

The Transtar 120 is billed as "the personal, portable daisy-wheel printer." It measures just 17½ inches wide, 4¾ inches high, and 12 inches deep. It can print boldface characters, underlined characters, and subscript and superscript characters, and Vivitar says that it is compatible with software designed to be run on Diablo printers. Its printing speed is 14 characters per second, and pitch is dip-switch selectable to 10, 12, and 15 characters per inch.

One special feature of the Transtar 120 is an automatic paper-loading system that allows single-sheet paper to be loaded into four different starting positions at the touch of a button. With this feature, you can start different kinds of documents at different positions on a page.

The Transtar 120 can be purchased with either a standard Centronics-style parallel interface or a standard RS-232C serial interface. It can handle paper up to 12 inches wide. It is compatible with print wheels designed for the Silver-Reed EX-55 electronic typewriter, and it uses a standard, easy-to-change Olivetti-compatible ribbon that is available in either fabric or carbon versions.

Vivitar's other daisy-wheel printers are the Transtar 130, which has a 17-inch carriage and prints at 18 characters per second, and the Transtar 140, a 132-column serial-interface unit that prints at 40 cps.

The Model 130 has a 12-inch carriage and is equipped with the same kind of auto-load single-sheet feeder as the one built into the Transtar 120. It prints bidirectionally, and it has proportional spacing capabilities. Like the Transtar 120, the Transtar 130 is code-compatible with programs written for printers in the the Diablo 1610/1620 class. It has a 2K print buffer, and it can print boldface, underlined, subscript and superscript characters. It is available with either a parallel or a serial interface, and it comes with a Courier 10 print wheel.

The most unusual printer in the Vivitar line is the Transtar 315, an impact dot-matrix unit that can print both text and high-resolution graphics in more than 30 colors and hues on a single pass of paper through the machine. The Model 315 can print 50 characters per second in full color.

The Transtar 315 uses a rotating platen, a four-color ribbon and a four-hammer print head to produce seven colors with more than 30 color and hue combinations.

The platen of the Transtar 315 is quite unusual: It does not move the paper, but has a set of horizontal ridges on its surface that are designed to bring the paper into firm contact with the four hammers built into the print wheel. During printing, the four-color ribbon moves across the print head diagonally, while the print head moves across the paper and the platen moves slowly upward. As the print head moves across the page, it prints one line of multicolored dots on the level of the paper that is exactly in front of the horizontal ridge on the platen. Then the ridge moves up exactly one row of dots, and the print head prints another row. This process results in the multicolor printing of 640 dots per inch horizontally across an 8-inch line.

The Model 315 is equipped with a full 96-character ASCII character set. It can print 78-dot by 8-dot characters with a density of 10 characters per inch, or 5-dot by 8-dot characters with a density of 13.3 characters per inch. The primary colors produced by the ribbon are black, magenta, yellow, and cyan.

The Transtar 315 can handle fanfold or single-sheet paper up to 10 inches wide. It comes with a standard Centronics-style parallel interface, and an RS-232C serial interface is optionally available. For users of Apple and Apple-compatible computers, an optional high-resolution graphics-dump interface card is also available. With this option, a computer can print any high-resolution graphics image in color on the Transtar 315 without having to exit a program.

Vivitar, Transtar 120 \$550; Transtar 130 \$699; Transtar 140 \$1,695; Transtar 315 \$599

PRINTERS

Manufacturer	Model	Type	Graphics/ Color Capable?	Page Width*	Print Speed (cps)†	Print Density (cpi)‡	Print Modes**	Price
Alphacom	42	Thermal	Yes/No	40 col.	80	10	T/G	\$100
	81	Thermal	Yes/No	80 col.	80	10	T/G	\$215
Amdek	Amplot II	Printer/ plotter	Yes/Yes	14"	N/A	Variable	T/G	\$1100
Anadex	DP-9000B	Dot matrix	Yes/No	8.5"	240	Variable	1	\$1200
	DP-9001B	Dot matrix	Yes/No	8.5"	188	Variable	1	\$1200
	DP-9001B	Dot matrix	Yes/No	15"	188	Variable	1	\$1200
	DP-9500B	Dot matrix	Yes/No	15"	240	Variable	1	\$1280
	DP-9501B	Dot matrix	Yes/No	15"	188	Variable	1	\$1280
	DP-9620B	Dot matrix	No/No	15"	240	Variable	2	\$1380
	DP-9621B	Dot matrix	No/No	15"	240	Variable	2	\$1380
	DP-9725	Dot matrix	Yes/Yes	15"	240	Variable	3	\$1625
	WP-6000	Dot matrix	Yes/No	15"	230	6-16	2	\$2700
	DP-6500	Dot matrix	Yes/No	15"	500	Variable	2	\$2995
Apple	Silentype	Thermal	Yes/No	8.5"	40	10	T/G	\$400
	Imagewriter	Dot matrix	Yes/No	10"	120	5-17	1	\$675
	410	Printer/ plotter	Yes/Yes	17"	N/A	N/A	T/G	\$945
	Daisy Wheel	Daisy wheel	No/No	15"	40	10-15	1	\$2165
C. Itoh	8510B	Dot matrix	Yes/No	10"	120	5-17	1	\$745
	8510S	Dot matrix	Yes/Yes	10"	180	5-17	2	\$825
	8510SC	Dot matrix	Yes/Yes	10"	180	5-17	2	\$925
	A-10	Daisy wheel	No/No	11.5"	18	Pica, Elite	1	\$995
	1550B	Dot matrix	Yes/No	15.5"	120	5-17	1	\$995
	1550S	Dot matrix	Yes/No	15.5"	180	5-17	2	\$1225
	1550SC	Dot matrix	Yes/Yes	15.5"	180	5-17	2	\$1325
	8600	Dot matrix	Yes/No	80 col.	90	Variable	3	\$1400
Computer International	Daisywriter	Daisy wheel	No/No	16.5"	40	10, 12	1	\$1495
Comrex	CR-III	Daisy wheel	No/No	132 col.	23	10, 12	1	\$1000
Diablo	11CQ	Dot matrix	Yes/No	10"	160	5-16.5	3	\$995

PRINTERS (Continued)

Manufacturer	Model	Type	Graphics/ Color Capable?	Page Width*	Print Speed (cps)†	Print Density (cpi)‡	Print Modes**	Price
	32CQ	Dot matrix	Yes/No	15"	150	5–16.5	3	\$995
	620 API	Daisy wheel	No/No	15.2"	21	10–15	1	\$1095
	630 ECS	Daisy wheel	No/No	16.5"	40	10–15	1	\$2195
	630 API	Daisy wheel	No/No	16"	40	Pica, Elite	1	\$2340
Dynax	DX-15	Daisy wheel	No/No	13.5"	13	1–15	1	\$599 ¹ \$649
Dynax (Brother)	HR-25	Daisy wheel	No/No	16.5"	23	10–15	1	\$995 ¹ \$1045
Epson	RX-80	Dot matrix	Yes/No	8.5"	100	Variable	1	\$499
	FX-80	Dot matrix	Yes/No	8.5"	160		1	\$699
	FX-100	Dot matrix	Yes/No	136 col.	160	Variable	1	\$895
	LQ-1500	Dot matrix	Yes/No	N/A	200	Variable	3	\$1500
Fujitsu	TTP16	Thermal	Yes/No	10"	30	10, 12	T/G	\$625
	SP320	Daisy wheel	No/No	16"	48	10, 12	1	\$1499
	DPL24	Dot matrix	Yes/No	16"	240	10–18	T/G	\$1940
	SP830	Daisy wheel	No/No	16"	80	10, 12	1	\$2950
Genicom	3014	Dot matrix	Yes/No	15.5"	160	10–17	2	\$1350
	3024	Dot matrix	Yes/No	15.5"	200	10–17	2	\$1550
Infoscribe	500	Dot matrix	Yes/No	136 col.	150	5–16.5	2	\$1345
	1000	Dot matrix	Yes/No	136 col.	200	5–16.5	2	\$1645
	1100	Dot matrix	Yes/No	136 col.	220	5–16.5	3	\$1800
	700	Dot matrix	Yes/No	136 col.	150	5–16.5	2	\$1900
	1200	Dot matrix	Yes/No	136 col.	200	5–16.5	3	\$2000
	1400	Dot matrix	Yes/No	136 col.	200	5–16.5	3	\$2000
Juki	6100	Daisy wheel	No/No	13"	18	10–15	1	\$599
Mannesmann Tally	MT-160 I	Dot matrix	Yes/No	10"	160	5–20	1	\$698
	MT-160 L	Dot matrix	Yes/No	10"	160	5–20	2	\$798
	MT-1602	Dot matrix	Yes/No	15.25"	200	5–16.5	1	\$1695
	MT-1605	Dot matrix	Yes/No	15.25"	200	5–16.5	1	\$1695
	1802	Dot matrix	Yes/No	15.25"	200	5–16.5	2	\$1995

PRINTERS (Continued)

Manufacturer	Model	Type	Graphics/ Color Capable?	Page Width*	Print Speed (cps)†	Print Density (dpi)‡	Print Modes**	Price
Micro Peripherals	PrintMate 1	Dot matrix	Yes/No	8.5"	100	10-17	T/G	\$150
	PrintMate 9	Dot matrix	Yes/No	8.5"	100	10-17	T/G	\$600
	Sprinter	Dot matrix	Yes/No	9.5"	160	5-17	T/G	\$800
NEC	15-LQ	Daisy wheel	No/No	80 col.	14	10, 12	1	\$695
	PC-8025A	Dot matrix	Yes/No	15"	120	6-17	1	\$895
	Spinwriter	Daisy wheel	No/No	16"	23	10-15	1	\$1225
Okidata	Microline 80	Dot matrix	Yes/No	8.5"	80	10, 12	T/G	\$399
	Microline 82A	Dot matrix	Yes/No	8.5"	120	10, 12	T/G	\$499
	Microline 83A	Dot matrix	Yes/No	16"	120	10, 12	T/G	\$749
	Microline 92	Dot matrix	Yes/No	8.5"	40-160	10, 12	3	\$599
	Microline 93	Dot matrix	Yes/No	16"	40-160	10, 12	3	\$999
	Microline 84	Dot matrix	Yes/No	16"	50-200	10, 12	3	\$1395
	Pacemark 2350	Dot matrix	Yes/No	16"	350	10, 12	T/G	\$2695
	Pacemark 2410	Dot matrix	Yes/No	16"	85-350	10, 12	3	\$2995
Panasonic	KX-P1090	Dot matrix	Yes/No	15"	96	Variable	1	\$500
	KX-P1092	Dot matrix	Yes/Yes	10"	180	Variable	3	\$600
	KX-P1093	Dot matrix	Yes/No	15"	160	Variable	3	\$900
	KX-P1160	Dot matrix	No/No	15"	196	Variable	1	\$1550
	VP-67801P	Printer/ plotter	Yes/Yes	10"	N/A	Variable	T/G	\$1565
	VP-67802P	Printer/ plotter	Yes/Yes	14"	N/A	Variable	T/G	\$3200
Practical Automation	8-PLP	Dot matrix	Yes/No	80 col.	275	10-16.7	1	\$728
	15-PLP	Dot matrix	Yes/No	132 col.	275	10-16.7	1	\$1000
Primages	Primage I	Daisy wheel	No/No	14"	45	10-15	1	\$1995
Quadram	Quadjet	Ink jet	Yes/Yes	8.5"	80	Variable	T/G	\$895
Sanyo	PR 5000	Daisy wheel	No/No	12.5"	14	10-15	1	\$595
	PR 5500	Daisy wheel	No/No	17"	16	10-15	1	\$995
Siemens	2712	Ink jet	Yes/No	8.5"	270	5-16.25	T/G	\$2250

PRINTERS (Continued)

Manufacturer	Model	Type	Graphics/ Color Capable?	Page Width*	Print Speed (cps)†	Print Density (cpi)‡	Print Modes**	Price
Smith-Corona	D-100	Dot matrix	Yes/No	80 col.	140	Variable	1	\$395
	D-200	Dot matrix	Yes/No	80 col.	120	Variable	2	\$595
	TP-II Plus	Daisy wheel	No/No	13"	12	10-15	1	\$645
	D-300	Dot matrix	Yes/No	132 col.	140	Variable	2	\$795
Star Micronics	STX-80	Thermal	Yes/No	8.5"	60	5.5-11	1	\$199
	Gemini-10X	Dot matrix	Yes/No	10"	120	5-17	1	\$399
	Power Type	Daisy wheel	Yes/No	13"	18	10-15	1	\$499
	Gemini-15X	Dot matrix	Yes/No	15"	120	5-17	1	\$549
	Delta-10	Dot matrix	Yes/No	10"	160	5-17	1	\$549
	Delta-15	Dot matrix	Yes/No	15"	160	5-17	1	\$799
	Radix-10	Dot matrix	Yes/No	10"	200	5-17	1	\$849
	Radix-15	Dot matrix	Yes/No	10"	200	5-17	1	\$995
Tandy	TP-10	Thermal	Yes/No	4.25"	30	10.5	T/G	\$100
	DMP-120	Dot matrix	Yes/No	8.5"	120	10-16.7	1	\$500
	CGP-220	Ink jet	Yes/Yes	8.5"	37	12	T/G	\$700
	DWP-210	Daisy wheel	No/No	13"	18	10-12	1	\$800
	DWP-410	Daisy wheel	No/No	16"	25	10-12	1	\$1300
	DMP-2100	Dot matrix	Yes/No	8.5"	160	10-16.7	3	\$1995
Texas Instruments	850	Dot matrix	Yes/No	8.5"	150	Variable	3	\$500
	855	Dot matrix	Yes/No	11"	150	Variable	2	\$935
Toshiba	1340	Dot matrix	Yes/No	10"	96	10-16.7	2	\$995
	1351	Dot matrix	Yes/No	15"	192	10-16.7	2	\$2195
Vivatar	Transtar 12	Daisy wheel	No/No	12"	14	10-15	1	\$550
	Transtar 31	Dot matrix	Yes/Yes	10"	50	10, 13.3	T/G	\$599
	Transtar 13	Daisy wheel	No/No	17"	18	10, 12	1	\$700
	Transtar 14	Daisy wheel	No/No	132 col.	40	Variable	1	\$1695

* Page width is given in inches, if known; otherwise, in columns (col.).

† Maximum print speed, given in characters per second (cps).

‡ Given in characters per inch, when applicable.

** Number of print modes available. Some dot-matrix printers offer two or more printing modes: a "draft-quality" mode; a "correspondence-

quality" mode, which is slower but produces better-quality characters; and a "letter-quality" mode, which produces characters that rival those turned out by daisy-wheel printers. T/G indicates both text and graphics capability.

¹ Indicates parallel printer; second price is for serial printer.

MODEMS

Not too long ago, communications was an interesting but not generally useful field for microcomputer users. The ultimate possibilities were tantalizing, but the reality was severely limited. Things have changed. Communications has become one of the fastest growing and most important fields in microcomputing today.

On the hardware side, getting into communications is simple enough. Aside from a computer and a phone line, you only need one piece of equipment: a modem.

Modem is short for "MODulator-DEModulator," a complete description of what the device does. On the transmitting end, it takes computer-generated signals and modulates them, or converts them to a signal that can be sent over the phone lines. On the receiving end, it takes the modulated signals and demodulates them, or converts them back to a signal that the computer can understand.

The major complication in choosing a modem is that there are different techniques for modulating signals. Each of these results in a different set of protocols, or signalling standards, and each has its own characteristics.

This makes choosing a modem something like choosing a radio. You don't have to know how a radio works or how FM differs from AM, but you have to know that there is a difference and you have to know which one you need.

MODEM PROTOCOLS

The four most common protocols are Bell 103, Bell 212A, Bell 202, and Racal-Vadic VA3400. Aside from the technical specifications, these can be distinguished from each other by two characteristics: their maximum reliable speed of transmission and the presence or absence of full two-way communications.

Baud Rate: Speed of transmission is usually measured in "baud," a unit roughly equal to one bit of data per second. A more meaningful measurement for most people is characters per second. The rule of thumb for the conversion is to divide by 10; 300 baud, for example, translates into 30 characters per second.

Knowing the baud rate of a system is important. Even if you are using the same protocol as another system, you still can't communicate unless you're using the same baud rate as well. Similarly, your computer and your modem must both be set at the same baud rate, or you'll get nothing but garbage on your screen.

Full-Duplex/Half-Duplex: A basic distinction in communications is between simplex (one-way) and

duplex (two-way). Television is simplex. Telephones are duplex.

Within duplex communications, there's a further distinction between half-duplex and full-duplex. CB radio is half-duplex: Both sides can send information, but only one side can send at a time. Telephones are full-duplex: Either side can send information whenever it wants, without waiting for the other to finish.

Most modems have a switch labeled "Full-Duplex/Half-Duplex." This is mislabeled. It should be called "Distant Echo/Local Echo." Unfortunately, the mistake is nearly universal, and we're stuck with it.

The Full-Duplex setting assumes that the system you're talking to is echoing each character you send. When you type a character, it doesn't show up on your screen until it has been sent to the other computer, received, retransmitted, and received by your system. If the character shows up correctly, you know it was received correctly at the other end. Of course, if the other computer is not echoing the transmission, you won't see anything you send.

The Half-Duplex setting solves this problem by providing a local echo. When you type a character, your modem not only sends it to the other computer, it echoes it back to your computer. Regardless of the setting on the switch, though, you are still engaged in full-duplex communications. What is changing is the *echoplex*: distant echo or local echo, echoplex or no echoplex.

BELL 103/113 PROTOCOL

The Bell 103 protocol is probably the most widespread protocol in microcomputer communications. It is so common, in part, because it has been around the longest. It is also the least expensive: Some 103-compatible modems sell for under \$100.

Protocols get their names from specific models of modem. In this case there are two models involved, the Bell 103 and the Bell 113. Modems that use this protocol may be called 103-compatible, 113-compatible, or Bell series 100-compatible. These terms are all equivalent.

The 103 protocol is a full-duplex standard. You will often see the statement that it has a maximum reliable speed of 300 baud over standard phone lines. The protocol is actually reliable at twice that rate. As a practical matter, though, nearly all 103-compatible modems have a 300 baud maximum. You can find modems that work at 450 baud or 600 baud, but there's hardly anyone you can talk to at the higher rates.

BELL 212A PROTOCOL

The Bell 212A protocol is also a full-duplex standard. The advantage of this protocol is speed: 1200 baud on standard phone lines. The disadvantage is price. The least expensive 212-compatible modems are in the same price range as the most expensive 103-compatible modems. Still, thanks to the speed advantage, this protocol is rapidly gaining in popularity. The official name of this protocol is "Bell 212A," but except among technical purists, the "A" usually gets dropped.

OTHER PROTOCOLS

Two other protocols you should know about are Bell 202 and Racal-Vadic VA3400. The 202 protocol is a half-duplex, 1,200 baud standard. The VA3400 protocol is a full-duplex, 1200 baud standard. Odds are you don't need either of these, unless you have a specific system in mind that will only communicate with one or the other. When shopping for a 1200 baud modem, be careful not to buy a 202 or a VA3400 modem when you really need a 212-compatible modem.

Other protocols are of little interest to most microcomputer users. Most of these are for expensive, high speed modems that need special phone lines. The rest define standards that are used outside the United States.

CHOOSING PROTOCOLS

Your choice in protocols will be determined largely by others. For most hobbyist bulletin boards, you must use a 103-compatible modem. For some information utilities, notably LEXIS and NEXIS, you must use a 212-compatible modem. Most commercial online systems will let you use either.

You may find you need more than one protocol. You can get it by buying more than one modem, but you can usually save some money by buying a multiple modem. The most common combination is 103/212-compatible. You can also find modems that are 103/202-compatible, 103/202/212-compatible, or 103/212/VA3400-compatible.

CONNECTING THE MODEM TO YOUR COMPUTER

The most common way to connect a modem to a computer is through an RS-232 port, an industry-wide standard for connecting all sorts of computer equipment. Nearly all microcomputers have an RS-232 port either standard or as an optional feature. Most stand-alone modems also come equipped with an RS-232 port.

If you don't have an RS-232 port on your system, or if it's already being used, you will need a computer-specific modem. These come in two varieties. One kind comes on a board that slips directly into one of the computer's slots and automatically makes the right connections to the system. Several modem boards are built for the IBM PC, others for the Apple II or for S-100 computers. The other kind of computer-specific modem comes as a stand-alone device with cabling and connectors for a given system. These may plug into an Atari SIO port, an Apple game port, or a Commodore user port—the three most common examples.

The major advantage of computer-specific modems is that they leave your RS-232 port free for other purposes. The major disadvantage is that if you buy a new computer system you'll have to get a new modem as well.

A second benefit of computer-specific modems is that either they come with an appropriate cable to connect them with your computer or they don't need a cable at all. Most RS-232 modems omit the cable, since cables must be wired differently for different computers.

CONNECTING THE MODEM TO THE PHONE LINE

There are two choices for connecting a modem to the phone line: acoustically coupled and direct-connect.

Acoustically coupled modems communicate over the phone just as people do, through the phone handset. The modem comes with two rubber cups that fit the handset. At the bottom of one cup is a microphone, so the modem can "listen" over the handset speaker. At the bottom of the other cup is a speaker, so the modem can "talk" into the handset microphone. To establish communications, you place the handset in the cups. To end the conversation, you take the handset from the modem and hang up the phone.

The advantage of acoustically coupled modems is that they can work with any phone that has a standard handset. You can take them on the road without worrying about how to connect them with your hotel's telephone system. The disadvantage is that they can pick up noises that generate random characters on your screen and interfere with communications. Acoustic coupling is almost never found on 212-compatible modems.

Direct-connect modems plug directly into the phone system. There are variations on how this is done, but most plug directly into the wall module, where the phone usually goes. Once plugged in,

they can be left there permanently. Some of these modems include a female connector in the body of the modem for the phone to plug in. Others require a "Y" connector at the wall so the modem and phone can both be plugged in. (Usually the "Y" connector must be bought separately.) A few direct-connect modems plug into the phone itself, where the handset normally plugs in. These modems must be reconnected each time you establish communications.

Direct-connect modems can only be used with phones equipped with modular plugs.

BASIC FEATURES

Modems can have all sorts of features, but there are three in particular that you should be aware of. These are often left out of inexpensive modems as a way of cutting costs. In each case, make sure you can do without the feature before you buy a modem without it.

Full-Duplex/Half-Duplex Switch: Since nearly all communications take place with full-duplex, or echoplex, some modems are permanently set to full-duplex. If all your communications will be with commercial information utilities, hobbyist bulletin boards, and other microcomputer users, you can probably do without this capability.

Originate/Answer Mode: In full-duplex communications, each modem must send one set of tones and listen to another. Otherwise each modem would be able to hear only its own transmission. These two sets of tones are called "originate" and "answer." Some modems come in originate-only or answer-only models. By convention, most host systems use answer mode, which means you almost certainly do not want an answer-only modem. You may be able to get by with an originate-only modem, but if you ever try to communicate with a friend or business associate, at least one of you has to be able to use answer mode.

Variable Baud Rates: You will usually want to use 300 baud with a 103-compatible modem, but there are some networks that use other speeds. The Telex I network, for example, uses 50 baud. Some modems work at 300 baud only. Others use some, but not all, of the slower standard speeds. Still others can use any standard speed between 0 and 300 baud. Find out which speeds you need, then make sure the modem you get can handle them.

OTHER FEATURES

Other modem features include automatic dialing, automatic answer, and automatic repeat dialing. Some of these are important for specific applications, but more often they represent added convenience

rather than added capability. Let your budget decide whether the added convenience is worth it.∞

ANCHOR VOLKSMODEM

The Anchor VOLKSMODEM is a 103-compatible, direct-connect, RS-232 modem. It comes with a slim instruction pamphlet and with cables for connection to your computer and phone lines. There is no power cord. The modem runs on a single nine-volt battery, which must be purchased separately.

The VOLKSMODEM is one of the few modems that comes with its own RS-232 cable, so that all you have to do to connect it to your computer is plug it in. This saves you the hassle and cost of finding or putting together a cable, and it makes the VOLKSMODEM exceedingly easy to install. You do have to order it with the correct cable in the first place, however. In most cases this is simply a matter of telling the dealer which machine you plan to run it on. Once you get the modem home, all you have to do is plug the RS-232 cable into the modem and computer, plug the phone cable into the modem and phone line, and plug a phone into the modem. And put in a battery.

The VOLKSMODEM is also exceedingly easy to use. It has only two switches. One chooses between full- and half-duplex. The other chooses between voice and data. When the modem is set to voice, you use the phone normally. To use the modem, you establish a phone connection, then switch to data mode. The phone will go dead and you will hear an audible tone from the modem. When communications are established, the tone stops. One very helpful feature is that the modem will automatically set itself to answer mode or originate mode as appropriate. The only complication in using the VOLKSMODEM is that if your battery is dead (or you've forgotten to put it in), the modem will still seem to be working, complete with the audible tone. Except that you won't be able to communicate with anyone.

In addition to ease of installation and ease of use, this no-frills device has at least one other thing going for it. It is one of the least expensive modems available. If you are looking for a basic, direct-connect modem, this is a good place to start.

Anchor Automation, \$79.95; RS-232 cable \$12.95; Atari game port cable and software \$39.95

BIZCOMP 1012 INTELLIGENT MODEM

The Bizcomp 1012 Intelligent Modem is a 103/212-compatible, direct-connect, RS-232 modem.

This is a sophisticated device that can serve most communications needs.

The control panel on this device consists of one switch, one light, and your computer keyboard. The switch turns the modem on and off. The light has several uses that we'll come back to shortly. The keyboard is the most interesting part.

As the name implies, the 1012 Intelligent Modem has built-in "intelligence." This comes in the form of firmware: a program permanently written on a chip inside the modem. The program lets you communicate with and control the modem from your keyboard or through your communications program.

The commands for the 1012 are no more than electronic switches. Many of them are simple on-off toggles—for turning automatic answer mode on or off, for example, or for selecting pulse dialing or tone dialing. Other commands let you select the baud rate, tell the modem to dial a phone number, or tell it to hang up the phone. You can even manually dial a phone number, or manually answer the phone, then tell the modem to turn on in either answer mode or originate mode.

The one complication in setting up the 1012 comes from its option switches. These determine the default settings for several important functions. The switches are located on the back of the modem, where you may have some difficulty getting to them once the unit is fully installed. The explanation of the settings is buried in the middle of the reference manual. It pays to read that section first, then take the time to set the switches the way you want them before you plug everything in.

There are two settings in particular you may want to change. As shipped, the modem is set to be in auto-answer mode whenever you turn it on. Unless you have a phone line dedicated strictly to your computer, you probably won't want to leave it this way. As it stands, whenever anyone calls, the modem will pick up the phone and squeal at them. This is not very useful if someone is calling to talk to you.

The other setting you might want to change is the default baud rate. As shipped, the modem is set at 1200 baud unless you tell it otherwise. You can reset it to a default of 300 baud or to something called "autobaud." Autobaud seems the most useful. When set this way, the modem expects to see a carriage return as the first character from your terminal or computer. You set your terminal or terminal program to the baud rate you want, hit the carriage return, and the modem automatically sets itself to the right baud rate. If you hit something other than the carriage return, the modem may set

itself to the wrong rate, but to recover, you need only turn the modem off, then on, and hit the carriage return again.

In using the 1012 to make a call, you will typically start by sending a carriage return to establish the baud rate, then a "T" for test. The modem will respond with the message "Self Test—fully functional." You can skip this step, of course, but it's simple enough to be worth doing. You then type "D" for "dial," followed by the number to call. Hit RETURN and the 1012 will dial the phone for you. It will also keep you posted with a "Dial Tone" message when it detects a dial tone, and a "C" when the connection has been established. You can abort dialing at any time by hitting any key on your keyboard.

All told, the 1012 has five operating modes: originate, answer, auto-answer, auto-dial, and repeat auto-dial. This last mode is an unusual convenience. It lets you tell the 1012 to dial a number *and keep dialing it* until it gets through to another modem. This is particularly helpful when dealing with hobbyist bulletin boards and other systems that can only talk to one modem at a time. It can also be useful when dealing with communications networks during their busy hours. When the 1012 finally establishes a connection, it will tell your computer or terminal to beep at you to get your attention. If your system isn't equipped to do that, you'll have to keep an eye on the screen to keep posted on the modem's progress.

The light on the 1012 serves several purposes. It functions as an on-off light, turning on whenever you turn the modem on. It functions as an "off-hook" indicator, turning off whenever the modem picks up the phone. It also functions as a Carrier Detect light, a Receive Detect light, and an Error Indicator. This light will not tell you as much as the four, six, or eight lights that you'll find on some modems, but it will tell you almost as much. If you're new to communications, moreover, you may find this one light less intimidating than a bank of them.

There are two important limitations on the 1012. First, it operates at full-duplex only. If you need half-duplex capability, you'll have to make sure your communications program will provide it. Second, the low-speed capabilities are limited to rates between 110 baud and 300 baud. If you need slower speeds for any reason, you won't be able to use the 1012.

Additional features on the 1012 include a series of sophisticated test modes and the capability for synchronous operation at 1200 baud. (Without getting into definitions, most microcomputer systems

use a communications scheme that is called asynchronous. Many mainframes use a scheme that is called synchronous. The 1012 will let you use either, so that your micro can talk to your office mainframe.)

The Bizcomp 1012 Intelligent Modem is a highly sophisticated unit, in the same class as the Hayes Smartmodem 1200. It deserves a close look from anyone looking for a top of the line modem.

The 1012 comes with a reference manual, a power cord, and an appropriate cable for plugging the modem into the phone lines. You will also need a cable for connecting the unit to your computer. You will probably want to buy a "Y" connector for the phone line as well.

Bizcomp Corp., \$649

BIZCOMP 1022 INTELLIGENT MODEM

The Bizcomp 1022 Intelligent Modem is similar in most ways to the 1012, except that it is 103-compatible only. As with the 1012, the 1022 is a full-featured, direct-connect, RS-232 modem. It comes with a manual, a power cord, and a cable for connecting to the phone lines. You will also need a cable for connecting the 1022 to your computer, and will probably want a "Y" connector so you can plug in a phone and the modem at the same time.

The 1022 uses the same set of commands as the 1012. In fact, aside from speed and protocols, the differences between the two modems are minor. The most obvious difference is in physical design. The 1022 is smaller, and it has no on-off switch or status light. There is no way to interact with it except through your computer or terminal. A third difference is that the 1022 has no option switches. If you don't like the default settings, you must change them each time you plug in the modem.

The one major problem with the 1022 is the manual. This is a serious contender for the worst modem manual ever written. It talks about such things as "the special two-character input stream, DLE EOT (ASC II hex codes, 10, 04). . . ." If you read the manual carefully, you will eventually realize that this command tells the modem to hang up the phone. What you won't find in the manual is that you can produce this "special input stream" at your keyboard by typing "Control-P, Control-D." There is simply no excuse for this kind of technobabble. It makes the manual incomprehensible, and renders the modem nearly useless to anyone who doesn't already have a firm grasp of communications.

Should Bizcomp ever rewrite the manual, the modem will be worth considering. Until then, stay

away from the 1022 unless you really know what you're doing.

Compatibility: Any RS-232 part
Bizcomp, \$249

BIZCOMP 2120 PC:INTELLIMODEM

In its features, the Bizcomp 2120 PC: IntelliModem is similar in most ways to the Bizcomp 1012 or 1022. The biggest difference is that this is not an RS-232 device. It is a modem-on-a-board for the IBM PC.

The 2120 comes with a manual and with a cable for connecting the modem to the phone lines. A built-in phone jack will let you plug in a phone, which you can then toggle on and off through your modem. This gives you maximum convenience in switching back and forth between modem and voice communications.

A word on the manual. Bizcomp modems are generally designed for ease of use, while the manuals are apparently thrown in as an afterthought and vary from tough going to incomprehensible. Not so with the 2120. The preliminary manual that came for review is a vast improvement over anything previously seen from Bizcomp. It is clear, straightforward, and reasonably free of technobabble. It still assumes that you are starting with some prior knowledge of communications, however. If you don't have that knowledge, you won't find the manual simple, but you will probably be able to work your way through it without too much trouble.

The 2120 also comes with a communications program, *PC: IntelliCom*. This is not the most sophisticated software available, but it will handle most interactive communications needs. If you find yourself outgrowing the program, moreover, you can move on to virtually any other communications program that you like. In the meantime, Bizcomp starts you off with a fully integrated package. This will make it much easier to get your system up and running, which is ultimately much more valuable than starting with software that is more sophisticated and much harder to use.

Compatibility: IBM PC, 64K RAM, disk drive, disk BASIC, 80-column monitor
Bizcomp, \$499

CERMETEK INFO-MATE 212A

The Info-Mate 212A is a 103/212-compatible, direct-connect, RS-232 modem. This is a full-featured, intelligent device aimed squarely at the high end of the personal computer communications

market. It will operate at 110, 300, and 1200 baud only.

This modem is clearly meant to compete head-to-head with the much better known Hayes Smartmodem 1200. Physically, it's similar to the Smartmodem in size and general design. More important, it offers most of the features of the Smartmodem, plus a few of its own.

Basic features on the Info-Mate include auto-dial, auto-answer, manual dial, and manual answer. An on-board memory lets you store up to 52 phone numbers or log-on sequences. The memory has a battery backup to protect the information during power failures. The backup uses 3 AA batteries.

The auto-dial feature includes five variations: 1) You can enter a number to dial from the keyboard; 2) You can have the modem dial a number from the on-board memory; 3) You can enter two numbers from the keyboard, telling the modem to dial the second number as an alternate if the first doesn't answer; 4) You can give the modem two numbers from its memory, with one as an alternate; and 5) You can tell the modem to redial the last number entered. With each of these variations, you can tell the modem to keep trying if there is no answer. The maximum number of retries is 14.

In addition to the on-board memory, the Info-Mate 212A has a few other features that you won't find on the Smartmodem—or on most other intelligent modems for that matter. The “adaptive dialing” feature lets the Info-Mate choose between pulse and tone dialing automatically. The modem first listens for a dial tone, then tests the phone line by tone dialing the first number. If the dial tone is still there, the modem switches to pulse dialing and starts over again. Otherwise it continues dialing the rest of the number with tone dialing. When set for adaptive dialing, the modem will run this test each time it hears a dial tone.

If you prefer, you can include a command for either pulse or tone dialing along with the phone number, and you can change from one to the other in mid-number. This will skip the testing step and speed up the dialing slightly. Cermetek generally recommends this anyway if you run into problems. There are some circumstances that can confuse the adaptive dial mode.

A more important feature for some applications is that the modem is capable of synchronous communications as well as asynchronous communications. You may need this ability in talking to certain systems, including your company's mainframe computer, for example.

One other useful feature on the Info-Mate is its eight test modes. You have to be familiar with com-

munications before you can use these efficiently, but once you understand how to use them, they will help you pinpoint any problems you run into.

The front panel on the Info-Mate has seven status lights as compared to eight on the Smartmodem. Six of these are either identical to their counterparts on the Smartmodem, or else serve an equivalent function. The seventh indicates errors in the test modes. Two lights that you won't find on the Info-Mate are the Off Hook light and the Auto Answer light.

The lack of an Off Hook light means you have no easy way to tell if the modem is on the phone line or has hung up. This is at least partly made up for by a disconnect method that the modem sends to your screen when you hang up. The lack of the Auto Answer light is more troublesome. It means you have no easy way to see whether the modem is set for Auto Answer. And that, in turn, means that the modem may pick up the phone when you do not want it to. Either possibility can be more than a little annoying.

As with any intelligent modem, you can control the Info-Mate either through your software, or directly from your keyboard. Be aware that this modem is not Hayes compatible, which means it will not generally work with software designed for the Hayes. There is at least one sophisticated communications program that will work with the Info-Mate however: *Crosstalk XVI*.

The one real drawback to this modem is the manual. Unless you are thoroughly familiar with communications, you are likely to find it incomprehensible. And even if you are familiar with communications, you may find it tough going. About the best I can say for the manual is that it is an improvement on earlier Cermetek manuals, which were even less helpful.

It is the manual more than anything else that keeps the Info-Mate from deserving a wholehearted recommendation. If you are new to communications, it is probably best to stay away from this one. On the other hand, if you are already familiar with communications, the Info-Mate deserves your attention. You'll find that it can stand up to a point-for-point comparison with the competition, and manage to hold its own.

Compatibility: Any RS-232 port.
Cermetek, \$595

ERA 2 PERSONAL COMPUTER COMMUNICATIONS SYSTEM

One of the most frustrating things about getting started in computer communications is that you

usually have to put the system together yourself. At the very least, this means picking out a modem and communications program that can work together, then figuring out how to *make* them work together. This is known in the trade as "systems integration," and is no mean feat if you don't know what you're doing to begin with.

Era 2 is a communications package that eliminates the job of systems integration. It does that by the simple strategy of starting you out with a fully integrated communications system. The Era 2 package is part hardware, part software. It is available in computer-specific versions for the IBM PC, the PC jr, and the Apple II, II+, and IIe.

The hardware side of Era 2 is a full-function, 103/212-compatible modem-on-a-board. The software is a fairly sophisticated communications program. The package also includes a manual and a cable to connect the modem to your phone lines. You will not need a "Y" connector; the modem contains a female phone jack where you can plug in a telephone.

Era 2 is not the only communications package that comes with everything you need. What makes it stand out from the others is that the information on both the hardware and software is fully integrated in a single manual. This means you can find everything you need to know all in one place, presented in a logical and, above all, useful order. Most other packages give you two or more manuals and leave you with the job of integrating the information.

The Era 2 manual has other good points. It is written at a level appropriate for a rank beginner in computer communications, yet contains enough information to be useful even to advanced users. Even nicer, it is designed so you can learn just as much or as little communications theory as you care to bother with. If you want to learn what various terms mean, you'll find explanations in the manual. If you'd rather skip them, you can do so while still learning how to use the modem and program.

The Era 2 modem is similar in most ways to the Hayes Smartmodem 1200 or 1200B. In fact, it shares the same set of commands and, according to Microcom, will work with just about any software designed for the Hayes. Features include manual originate, manual answer, auto-answer, and auto-dial modes. Various commands let you hang up the phone, control duplex setting, and choose between pulse and tone dialing. As with the 1200B, the Era 2 modem can be controlled either through software or through commands typed at your keyboard.

As of this writing, there is some slight incompatibility between the Era 2 modem and the Hayes. The only program affected, according to Microcom, is Smartcom II. Microcom also expects that the modem will be completely compatible with the Hayes by the time this catalog is published. Upgrades will be available to current owners.

Keep in mind that the software is an important part of the Era 2 package—just as important as the hardware. A fairly sophisticated program, it may well take care of all your needs. Basic features include auto-dial, auto-log-on, and the ability to send or receive disk files with or without Microcom's own error-correcting protocol, MNP, the Microcom Networking Protocol.

The program will let you create as many "set-up" files as you need to match the different online systems that you use. Each file can contain the settings for communications parameters, a phone number for automatic dialing, and up to ten programmed function keys for any common commands you use on that system. You can even set the file for automatic unattended operation, in which the program will "wake up" at a given time, dial a remote system, log-on, get some information, save it to disk, log-off, and hang-up the phone.

Microcom, incidentally, is making much of MNP, declaring it to be a new standard in personal computer communications. Thus far, MNP and Era 2 are much too new to know whether they will become a standard, but according to Microcom the protocol is being incorporated into communications programs that will be sold by IBM, Apple, and Tandy. Perhaps more significant, Microcom says that the protocol is being supported by Telenet, Uninet, MCI Mail, and Dow Jones Information Services.

If MNP does become a standard, it will be largely because it is somewhat easier to use than other error-correcting protocols. It makes certain choices for you automatically instead of forcing you to manually set your program. This means you don't have to know as much about the technical side of communications in order to send or receive files without errors.

Era 2 is an impressive package at a competitive price. Its totally integrated approach makes it appropriate for the communications novice. Its ultimate capabilities make it appropriate for the advanced user.

Microcom, \$429

HAYES MICROMODEM IIe

The Hayes Micromodem IIe is a 103-compatible,

direct-connect, modem-on-a-board for the Apple II, Apple II Plus, Apple IIe, and Apple III. It comes as part of a "complete telecomputing system" that includes the modem, an Owner's Manual, the Hayes Smartcom I communications program, and everything you need to install the modem in your Apple.

The Micromodem IIe will work at 110 or 300 baud. Other features include full- or half-duplex, and answer or originate modes. In auto-answer mode, you can tell it how many rings to wait before picking up the phone. In originate mode, you can tell it to use either pulse or tone dialing. The modem also includes a speaker so you can follow the progress of the call and abort it if something goes wrong. When the modem establishes communications, the speaker turns off.

The Micromodem IIe is controlled through electronic switches. This gives you two choices for using it. Either you can learn the commands for the modem and control it from your keyboard, or you can use software that will send them automatically as needed. One of the advantages of using Smartcom I with the Micromodem IIe is precisely that it will take care of that for you. To set the baud rate, for example, you go to Smartcom I's parameter menu and change it there. The program then sends the appropriate command to the modem. This ability is far from unique, however. The Hayes modems are so common that nearly all of the major communications programs are set up to work with them.

Smartcom I is not the most sophisticated communications software for the Apple, but it is sophisticated enough to handle most communications needs. It will not only let you talk to other systems, it will let you send and receive files to and from disk. In addition, it will work with three operating systems—DOS 3.3, Pascal, and CP/M. And of course it has the advantage of forming a completely integrated system with the Micromodem IIe. You may eventually outgrow the program, but it's not a bad idea to start with it and stay with it until you're thoroughly familiar with the Micromodem IIe.

The manual deserves special mention. Far from being an afterthought, it is an important part of the package. Hayes has clearly put some time and money into making it as useful and as usable as possible. In guiding you through the installation procedure, for example, the manual uses color photographs to show each step. They are so well chosen that it seems nearly impossible to misunderstand them.

This same care appears throughout the manual, in everything from the choice of material covered, to the clarity of writing, to the carefully designed

layout. It even shows in little things, like the labeled section tabs that are enclosed in plastic so you can't accidentally rip one off.

The result succeeds both as instructional material and as a reference. The novice will find all the information needed to get started, including a general introduction to the world of telecommunications. The more advanced user will find the technical details he or she may be looking for. Both will find that the manual is complete, heavily illustrated, and totally understandable.

Hayes Microcomputer Products, \$329

HAYES MICROMODEM 100

In ancient times, before IBM entered the microcomputer market, the S-100 bus structure was considered the de facto standard of the industry, and any number of systems were built around an S-100 card cage. Many of the best computers available still use this standard. The Micromodem 100 is for them. It is a 103-compatible, direct-connect, modem-on-a-board that can be used with just about any S-100 bus system.

The Micromodem 100 comes with everything you need to install it in your system. The S-100 board, of course, goes inside your machine. A ribbon cable leads to a second unit, the Microcoupler. This device is a kind of buffer zone between your computer and the phone system. Such couplers are required on all direct-connect modems, but they are usually built into the modem unit. The Micromodem 100 takes advantage of the coupler's location outside the machine to provide an "off hook" light to tell you when the system has picked up the phone. A standard telephone cable runs from the coupler to a phone jack. If you want to use a phone at the same location, you'll need a "Y" connector as well.

As shipped, the Micromodem 100 will communicate at 110 baud or 300 baud. Other speeds below 300 baud are possible, but not through simple software control. Operating modes include manual answer, manual originate, auto-dial, and auto-answer.

Software for the Micromodem 100 can be a problem. Because this modem connects to the computer through the S-100 bus system rather than through an RS-232 port, not all programs work with it. The manual includes a reasonably flexible program that you can either type in yourself or order from Hayes for \$25, but it is far from the most sophisticated communications program available. You will also find enough information in the manual so you can write your own program, if you have

the knowledge and inclination, or even patch other programs to work with the modem. MITE, Crosstalk, and many of the other sophisticated communications programs will work with the Micromodem 100, but if an elementary program fits your needs, you will have to make sure that it works with this board.

Hayes Microcomputer Products, \$399

HAYES SMARTMODEM 1200; HAYES SMARTMODEM 300

The two Smartmodems from Hayes Microcomputer Products are both direct-connect, RS-232 models. In most respects, from the design of the case to the functioning of the modem, the two are essentially identical from the user's point of view. Both connect to the computer the same way, both connect to the phone lines the same way, and most important, both share the same "intelligence."

As the names imply, the major difference between the two models is in the communications protocols they use and in their maximum baud rates. The Smartmodem 300 is a 103-compatible device with a maximum speed of 300 baud. The Smartmodem 1200 is a 103/212-compatible device with a maximum speed of 1200 baud. This review is based primarily on the Smartmodem 1200, but except where talking specifically about 1200 baud, 212-compatibility, all comments apply to the Smartmodem 300 as well.

The Smartmodems suffer from one flaw, and it is severe enough to require a mention even before their many merits. As a rule of thumb, when you turn your equipment on or off it's best to turn your computer on first and off last. This eliminates the possibility that random power-on surges will run from your peripherals to your computer and ruin a chip. With most modems, you can safely ignore this rule. With the Smartmodems, you cannot. One of the reviewers destroyed two chips in precisely this way, by turning the Smartmodem on when the computer was already in use.

In fact, the situation is worse than that. As with most modems, the power cord on the Smartmodem ends in a transformer that plugs into the electrical socket. It is possible to lose data from your system simply by plugging in the Smartmodem's transformer *even when the modem is off*. The moral here is to start by plugging in the transformer, then turn on the modem, and only then turn on the computer.

There are fewer complications in using the Smartmodems than there are in turning them on.

Setting the baud rate, for example, is automatic. In originate mode, the Smartmodem sets itself to the same baud rate as your computer or terminal. In answer mode, it matches the baud rate of the other modem. They work at all standard speeds between 0 and 300 baud, and of course the Smartmodem 1200 will work at 1200 baud as well.

If you are controlling the modem directly from your keyboard, making a call is as simple as putting your terminal or terminal program into interactive mode, and typing "AT D," followed by the number to dial. The "AT," for "ATtention," is the first entry in all commands. The Smartmodem uses this to set its baud rate. The "D" is for "dial." The Smartmodem picks up the phone, dials the number, and waits for a modem to answer on the other end. A built-in speaker lets you follow the progress of the call. If all goes well, a modem will answer the phone at the other end, and you will hear the two modems establishing the connection. At that point the Smartmodem will put the message "CONNECT" on your screen, and turn the speaker off. If there is no answer on the other end, it will put the message "NO CARRIER" on your screen and hang up the phone.

Putting the modem into any of its other modes is just as simple. For manual answer or originate, you make the phone call manually, then give the modem the command to pick up the phone in either answer or originate mode. For auto-answer, you tell it how many rings to wait before it picks up. (As shipped, auto-answer mode is off unless the modem is told otherwise. If you prefer, you can reset a configuration switch so that the answer mode will normally be on.) There is also a "Reverse" mode in which the Smartmodem will auto-dial a number, then establish communications using answer mode rather than originate mode. This is useful for dialing an originate-only modem.

Other basic commands on the Smartmodem let you hang up the phone, set the modem to half-duplex or full-duplex, or choose between pulse dialing and tone dialing. You can even change between pulse and tone in midstream. This is important if you're calling through a switchboard or local phone lines that require pulse dialing, but want to place the call through a long-distance carrier like Sprint or MCI that requires tone dialing.

Two last features of the Smartmodems ought to be mentioned. First, they have a bank of status lights on the front of the unit—seven in the 300 baud model, eight in the 1200. These tell you whether the modem is on and ready, whether your computer or terminal is on and ready, whether the modem is set for high speed or low speed, whether

automatic-answer mode is on, whether the modem is online, whether it is in communications with another modem, and whether it is sending or receiving information. These lights can be confusing at first, but they can also be more than a little helpful once you learn what the abbreviations stand for. When something goes wrong, they can help you track down the source of the problem.

Finally, the Smartmodems are nothing if not flexible. The built-in program has 19 basic commands and another 16 "registers" you can use to fine tune the various settings. These let you adjust such things as the length of time to wait for a dial tone before dialing, or let you set the speaker so it is always off or always on. There is enough flexibility built into the units so that you can adjust it to fit your communications needs. These are modems that you're not likely to outgrow.

The Smartmodems come with an owner's manual, a power cord, and a cable for connecting the modem to the phone lines. You will also need a cable for connecting the modem to your computer, and will probably want a "Y" connector so you can connect your phone and your modem at the same wall module.

The owner's manual for the Smartmodem is thick enough to be intimidating. Fortunately, as the manual itself points out, you don't need to read it cover to cover before you can use the modem. The ten-page chapter on installing the modem is filled with helpful illustrations. It also gives step-by-step instructions in reasonably clear, if unnecessarily formal, English. The one place where the instructions get muddled is in explaining the wiring for the RS-232 cable. That shouldn't matter though. By the time you're ready to install the modem, you should already have a properly wired cable on hand.

Hayes Microcomputer Products, Smartmodem 1200 \$699

HAYES SMARTMODEM 1200B

In terms of what it can do, this modem is virtually identical to the Hayes Smartmodem 1200. They share the same capabilities and nearly the same set of commands. However, the Smartmodem 1200 is a stand alone, RS-232 device that can be used with virtually any microcomputer. The 1200B is a modem-on-a-board, specifically for the IBM PC and close imitators. (According to Hayes, this definitely includes the Compaq and the Corona PC.)

There are a few minor differences in features as well. Because the 1200B goes inside the machine, for example, Hayes doesn't bother to put the bank of status lights on it. And the 1200B includes a

second jack where you can plug in a phone. This saves you from having to buy a "Y" connector.

Probably the most important difference between these two models has nothing to do with the modems themselves. It is simply that unlike the Smartmodem 1200, the 1200B comes as part of a complete communications package. This includes everything you need to get your system up and running: the modem, the cables, and the Hayes communications program Smartcom II. (The program will *not* work with the Texas Instruments computer.) Far from being a token program, Smartcom II is one of the better smart terminal programs for the PC. It is certainly sophisticated enough and flexible enough to handle most communications needs. Finally, the 1200B costs \$100 less than the 1200. If you have a machine it will work with, you'll find this package hard to beat.

Hayes Microcomputer Products, \$599

LCM-100 LINE CARRIER MODEM

LCM-100 Line Carrier Modems enable computers and peripherals to communicate without conventional cabling. The serial port of a computer may be connected to one LCM-100, and the port of a terminal or CRT to the other. The computer's LCM-100 could be plugged into an AC power outlet in one room, and the terminal's LCM-100 into an outlet in another room, perhaps several floors away. The terminal and computer then communicate through the building's existing electrical wiring.

The units operate by encoding and decoding electrical impulses overlayed on the electrical wiring with a technique known as "frequency shift keying." Physical separation has little effect, as long as the power outlets are served by the same power main. They can even be on separate circuits served by one main.

A computer may be in the basement and its terminal in the attic, or even separated by firewalls that cannot be pierced for cable routing. Transmission speeds of 9,600 baud have been tested successfully up to 800 feet, compared to the usual 200-foot maximum for RS-232C cabling.

Limitations include a lack of handshaking signals, so computer and peripheral must use software protocol (XON/XOFF, ACK/NAK, and so on). Interference may be caused by motors, dimmer switches for lights, and other noise. Most interference can be eliminated with special filters, line phase couplers, or replacement of offending devices, and the manufacturer offers help in doing so.

Communications Research Corp., \$365 per pair

LEXICON LEX-11, LEXICON LEX-12

The LEX-11 and LEX-12 are two variations on a single modem. Both are physically similar, and both function in much the same way from the user's point of view. Each is a 103-compatible, RS-232, acoustically coupled modem. The LEX-12 is a direct-connect modem as well.

As acoustically coupled modems, the two units are essentially identical. Each comes with an owner's manual and with a power cord. In each case, you'll also need a cable to connect the modem to your computer. The LEX-12 also comes with a coiled phone cord.

The LEX-11 has two controls. Both are three-position slide switches. The on-off switch has two "on" positions, one for answer mode and one for originate mode. The second switch chooses between full-duplex, half-duplex, and test mode. (In test mode the modem listens to itself, to let you check out your system as a unit.) To use the modem, you simply set it for full- or half-duplex as appropriate, establish the phone connection, turn the modem on in either answer or originate mode as required, then put the phone handset in the rubber cups. A raised diagram on the case shows you which side the handset cord goes on.

The LEX-11 has two status lights. The "Power On" light should come on as soon as you turn the modem on. The "Ready" light tells you when the connection has been established with another modem. This should come on shortly after you place the handset in the modem, and should stay on until you break the connection.

The LEX-12 is similar to the LEX-11 in both appearance and function. The major difference is that it is a direct-connect modem as well. The LEX-12 is unusual in that it goes between the handset and the phone. This has the advantage of letting you use the direct-connect feature even with a multiline phone. The only other difference between the LEX-11 and LEX-12 is that the LEX-12 is full-duplex only. The slide switch that handles duplex-setting on the LEX-11 is replaced on the LEX-12 with a switch that chooses between acoustic, direct-connect, and talking modes. This last setting lets you use the phone normally.

The LEX-11 and LEX-12 both come in battery-operated versions, the LEX-11B and the LEX-12B. These can work either from a wall outlet, or from two standard nine-volt batteries that fit inside the case. This is particularly helpful if you have a portable or transportable system. It gives you one less thing to carry and one less wire to plug in.

The owner's manuals on the LEX-11 and LEX-12 deserve special mention. They are short, well writ-

ten, and to the point. Part of the reason for their brevity is that the modems have few functions to explain, but part of the reason also is that the manual doesn't bog down in trying to explain communications theory or technology as some manuals do. It tells you how to use the modem and then stops. The result is a four-page booklet that tells you everything you need to know. All this makes it extraordinarily easy to get this modem up and running.

Lexicon Corp., LEX-11 \$145; LEX-11B \$185; LEX-12 \$165; LEX-12B \$205

MFJ-1232

The MFJ-1232 is a basic 103-compatible, acoustically coupled, RS-232 modem, but with a few interesting wrinkles.

The modem has three push-on/push-off switches. One turns the power on and off, one chooses between originate and answer mode, and one chooses between full- and half-duplex. There is no test mode. To use the MFJ-1232, you turn the power on, set the mode and duplex switches, establish a phone connection, and place the phone handset in the rubber cups. As with most 103-compatible acoustic modems, the 1232 has two status lights. One is a "power on" light. The other is a "carrier detect" light that indicates when 1232 is talking to another modem.

In addition to these more-or-less standard features, the 1232 has some less common capabilities as well. First, the unit has a built-in battery option. You can run it either from the power cord plugged into the wall outlet or from two standard nine-volt batteries. This is handy when you are travelling and cannot be sure of enough wall sockets.

Another nice luxury is a port for a cassette recorder. If you're using a dumb terminal program on your system, you normally won't be able to save a conversation to disk or tape. This cassette recorder port will let you bypass that limitation. Once it is saved on tape, you can play the conversation back through the modem and read it on your screen.

Finally, in addition to the RS-232 port, the 1232 has a TTL-level port. TTL-level signals are a fairly common I/O standard on small computer systems. The Apple game port, for example, is a TTL-level port. If you have an Apple II without a serial card, you may find this useful. In fact, MFJ sells an Apple "kit" for the modem. The kit, MFJ-1231, consists of software for the Apple II or II plus, and a cable for connecting the modem through the game port. Other small computers that can make use of the TTL-level signals include the Vic 20 and the Commodore 64.

Unless you buy the Apple adapter kit, you will have to purchase a cable to connect the modem with your machine. Omitting it is one way that MFJ keeps its price down.

MFJ Enterprises, \$129.95

THE MICROPERIPHERAL AUTO-PRINT MICROCONNECTION

The Microconnection comes in several versions that vary in both capabilities and in availability for different computer systems. The model reviewed here, the Auto-Print Microconnection, comes in two computer-specific versions. One comes with a cable that plugs into the Atari SIO bus connector. The other fits the Commodore 64 or VIC-20 user port. Aside from the cable, the two versions are essentially identical in design and function. They both come with an appropriate cable for direct connection to your phone line, they both come with the same user's manual, and they both feature the same auto-print capability.

This 103-compatible, full-duplex modem is significantly more than a bare-bones, no-frills device. In addition to manual answer and manual originate modes, it is also capable of auto-dial and auto-answer, if you have software that can support these features. If not, more than half the manual is devoted to programs written in the appropriate dialect of BASIC for your machine. All you have to do is type them in.

Auto-print is probably this modem's most important feature. If you own either an Atari computer or a Commodore 64/VIC-20, you will find few communications programs that will let you print a conversation as it takes place. Instead, you must capture the information in memory first, then send it to printer. And, of course, you have to hold up communications while you're waiting for the information to print out. The Auto-Print has a port that can work with "virtually any" Centronics-compatible printer, and will let you print the conversation as you go.

The manual that comes with this modem is reasonably clear and informative. Considering that it appears to have been written with a hobbyist in mind, it is remarkably free of technobabble. Its one bad flaw is the typeface, which is the size that is usually chosen for the small print on rental agreements and other forms of indentured servitude. With that one small exception, the Auto-Print Microconnection is clearly worth looking at if you're using an Atari or Commodore 64/VIC-20.

The Microperipheral Corporation, \$149.95

NOVATION APPLE-CAT II COMMUNICATIONS SYSTEM

As the name implies, the Novation Apple-CAT II Communications System is more than just a modem. In fact, it comes in enough discrete units to make it difficult to characterize. The basic unit is a 103/202-compatible, direct-connect modem-on-a-board for the Apple II, Apple II Plus or Apple IIe. This comes with Com-Ware II, a communications program that will work with Apple DOS 3.2, 3.21, or 3.3. It also comes with a set of owner's manuals and with all the cabling and connectors you need to install the modem in your Apple and to plug it into the phone system.

In addition, Novation sells a 212 Upgrade Card. This adds 212-compatibility to the unit. The resulting package is indeed a complete communications system for the Apple. In some ways it may be too complete: Most people will never need the modem's 212-compatibility, but they'll have to pay for it anyway.

The Apple-CAT II system represents a new trend in modem packages. It is designed around the premise that you should be able to buy everything in a single system, rather than having to put the pieces together yourself. This has some obvious advantages, particularly if you're a novice in communications. Unfortunately, Novation did not carry this concept over into the manuals. Instead of a single, fully integrated introduction to the system, you'll find four separate manuals. This leaves you no worse off than if you had bought the system as separate pieces, but it leaves you no better off either.

The Apple-CAT II is controlled through software. Typically, you make choices from a menu in a communications program, and the program sends the proper commands to the modem. This lets you set the Apple-CAT to answer mode, auto-answer mode, or originate mode, toggle it between 103, 202, and 212-compatibility, or set the system for half-duplex or full-duplex. It also lets you use the modem to dial your calls. In the simplest form, this means picking the "auto-dial" choice on a menu, then entering the phone number from the keyboard. The modem dials the number, waits for another modem to answer, then establishes the connection. If you get a busy signal, you tell the modem to hang up. Most programs will let you redial with a single command rather than forcing you to reenter the entire number. Many will let you store numbers in a phone directory. Dialing then becomes a matter of picking a number from the directory.

Com-Ware II, the software that comes with the

Apple-CAT II, is not particularly sophisticated, as communications programs go. It has minimal "smart terminal" capabilities; it will let you send and receive files, but it will not send or receive them directly to or from disk. Instead, you must load the information into memory first and then tell the program where to send it. This is clumsy at best. Fortunately, the Apple-CAT II is so popular that many other programs are designed to work with it. If this is your first modem, you might like to start with Com-Ware II, just to get a feel for what you want a communications program to do, but be aware that you are likely to outgrow it quickly.

Novation, Apple-CAT II \$389; with 212 Upgrade Card \$725; 212 Upgrade Card \$389

NOVATION CAT ACOUSTIC MODEM

The Novation CAT is a 103-compatible, RS-232 acoustically coupled modem. Its slim "Installation and Operation Manual" is revealing: There simply isn't much to say about this modem.

Installation is certainly simple enough. Plug in an appropriate cable, plug in the power cord, and go. Using the modem is also simple. The CAT has two controls, both three-position slide switches. One is an on-off switch, with two "on" positions that choose between answer mode and originate mode. The other chooses among full-duplex, half-duplex, and test mode. In test mode the modem listens to itself so you can check out your system as a unit. To use the modem, you set the full-duplex/half-duplex switch, establish the phone connection, set the modem for the proper mode, and put the phone handset in the rubber cups. An arrow labeled "cord" shows you which way the handset goes.

The CAT has two status lights. The "Power" light confirms that the modem is on. The "Ready" light confirms that the CAT is talking to another modem.

All this makes the CAT absolutely typical. In fact, if this modem is notable for anything, it is precisely that it is one of the best known and most readily available 103-compatible, acoustically coupled modems in personal computing. It is not just a standard modem. In a very real sense, it is *the* standard.

Novation, \$189

NOVATION J-CAT

Though the J-CAT is a 103-compatible, direct-connect modem, it is a distinctly atypical device. To begin with, it is not an RS-232 modem, although it will work with the RS-232 port on most computers. The J-CAT uses TTL-level signals. This is a dif-

ferent standard from the RS-232 standard, but there is a quasi-compatibility between the two. The key factor is how much variation has been allowed for in the design of the computer's RS-232 port. If the variation is large enough, you can use the J-CAT. This shows up most dramatically with RS-232 cards for the Apple II and the IBM PC. In each case, the J-CAT will work with some cards, but not with all of them.

Some other systems that can use the J-CAT are the Atari 850 Interface Module, the Fortune, the Eagle II, the Vector 3, the TI-99/4A RS-232 interface, the Osborne I and II (communications port only), and the Radio Shack Color Computer. Obviously, before you buy the modem, you will want to make sure it will work with your computer. If you can't test it first, check with Novation. If you have an Apple II or IBM PC, be prepared to tell them whose RS-232 card you're using.

The cable that comes with the modem uses a 25-pin, DB-25 male connector. This is the most common connector for an RS-232 port, but it is not universal. With most IBM PC cards, for example, you'll need a female connector. When you buy the modem, make sure you get an appropriate cable with it. Also, be aware that you may have to change the wiring, depending on how the connector on your computer is configured.

The J-CAT is about half the size of a phone handset, which makes it much smaller and lighter than most modems. This gives it an obvious advantage if you want to use it with a portable system. Oddly enough, the small size can also present a problem. Most direct-connect modems are designed to fit under a desk phone. Most often, the controls and status lights are on the front, where you can see them and reach them without having to move the phone. Another convenient place for such modems is on top of your CRT, with the controls and status lights at eye level.

Neither technique works with the J-CAT. It is the wrong size and shape to put under the phone, and if you put it on top of your CRT, you'll have to stretch to read the labels on the lights and the controls. Novation suggests mounting it on the side of your phone and supplies a strip of Velcro for that purpose. Here again, though, you may have some trouble seeing the lights and reading the labels. This is not a serious problem, but choose the spot for your modem carefully before you paste the Velcro strip anywhere.

Using the J-CAT is easier than finding the right place to keep it. For manual answer or manual originate, you start by establishing a phone connection. When you hear a modem at the other end, you

simply press the "Connect" button and hang up. The J-CAT does the rest. When you're finished, you press the "Disconnect" button, and the modem hangs up. An interesting feature here is that you don't have to set the modem to answer or originate mode. The J-CAT does that automatically, by switching back and forth from one to the other. When it finds itself talking to another modem, it locks into the proper mode.

There are two status lights on the J-CAT. An "off hook" light tells you when the modem has picked up the phone. A "ready" light tells you when it is talking to another modem. The only other control is a slide switch that turns the auto-answer mode on and off. There is no on-off switch. If the modem is plugged in, it is on. There is also no full-duplex/half-duplex switch. The modem is full-duplex only.

The J-CAT also has an auto-dial mode—or an auto-dial *capability*, at least. Most modems with automatic dialing have built-in intelligence. You enter a phone number from your keyboard, send it to the modem, and let the modem's built-in program interpret the number and dial the phone. The J-CAT has the capability for pulse dialing, but it doesn't have the smarts to go with it; if you want automatic dialing on the J-CAT, you have to write a program to get it. The Novation manual includes a sample program written in Applesoft BASIC.

If the J-CAT will work with your system, it is definitely worth considering. Even if you ignore the auto-dial capability, it is still a good buy. It offers substantially more-than-minimal capabilities at only a slightly more-than-minimal price.

Novation, \$149

NOVATION 103 SMART-CAT; 103/212 SMART-CAT

The Novation SMART-CATs qualify as full-featured, direct-connect, RS-232 modems. This review is based on the 103/212 SMART-CAT, but except for comments specifically about 1200 baud communications, it applies to both. The only difference between the two is the presence or absence of 212-compatibility.

The manual for the SMART-CAT does not explain the installation or operation of the modem as clearly as it might, but it is still better than most other modem manuals. Unfortunately, the manual is one generation behind the modem itself. It comes with a two-page addendum that apologizes for this and tries to explain the changes. The addendum is largely unreadable, which is unfortunate, because Novation has apparently added two new features and it is impossible to figure out what

they are or how to use them. Novation says that a new manual should be available by the time this book is published.

Using the SMART-CAT is straightforward. All features are controlled by electronic switches. You control the switches, in turn, either through your software or by putting your terminal program into interactive mode and typing the modem commands on your keyboard. To use the modem for manual answer or originate, you establish the phone connection, then type the command to pick up the phone in the appropriate mode. For auto dial, you type "D" for "Dial," along with the phone number. Other commands let you toggle the auto-answer mode on and off, set the modem for half- or full-duplex, or hang up the phone. You can choose between pulse and tone dialing, and you can set the modem to 110, 300, or 1,200 baud.

The SMART-CAT lacks a few conveniences. For example, when entering a number to dial, you can't back up and correct a mistake. You have to retype the whole command. Also, if you want to change the baud rate, you must do it manually. This means setting your software for the current speed of the modem, changing the baud rate, then resetting the software again. This is simply clumsy. The Hayes Smartmodem reads the first characters in the command line and sets itself to the right speed. More disturbing, in auto-answer mode the SMART-CAT will not automatically set itself to match the speed of the incoming call. This can be a serious obstacle to effective use of the auto-answer feature.

Overall, the SMART-CAT is a reliable device that works as advertised. It has a few limitations, but for most people these will be minor annoyances at worst. In comparison to the competition, notably Hayes Smartmodem and Bizcomp 1012, the SMART-CAT does a little less, but then it costs less too.

The SMART-CAT comes with an owner's manual, a power cord, a cable for connecting the modem to the phone lines, and a modular plug for connecting your phone to the modem. You will also need a cable for connecting the modem to your computer.

Novation, 103 SMART-CAT \$249; 103/212 SMART-CAT \$595

QUBIE 1200 BAUD AUTO-DIAL MODEM

The Qubie 212A is an accessory board for the IBM PC and compatible computers. It contains an asynchronous serial communications port, and a direct-connect modem. The serial port is addressed by the computer as COM1; or COM2; and can be controlled with the commands IBM de-

signed for similar ports on its accessory boards. Although an option allows the serial port to be used independently, it is generally dedicated to the modem. The modem supports the Bell 103 (30 characters per second) and 212A (120 characters per second) standards. It also automatically dials calls, answers incoming calls and selects the correct speed and originate or answer frequencies.

The Qubie board obtains all its power from the computer. The only visible evidence that it is installed is the optional RS-232 connector and two modular telephone jacks on the back. Either jack may be used to connect the modem to the telephone lines (a cable is included). A telephone is not necessary, but can be attached to the other jack.

The modem is designed to use the same commands as the popular Hayes Smartmodems. Its operation, however, is very different. Most modems use analog filtering to modulate and demodulate the tones used to send data over the telephone wires. Qubie has chosen to use digital filtering and actually employs four separate microprocessors to measure the tones millions of times a second. Digital filtering is apparently more economical, but on some local telephone systems (notably near Washington, D.C.), the Qubie often interprets static on the lines as data and makes communication difficult at 120 characters per second.

Using Hayes commands means the Qubie product can use the software written for the Smartmodems. In fact, it comes with PC-Talk III, widely acclaimed as the standard for IBM PC communications program. PC-Talk stores telephone numbers and communications parameters, sets up the serial port and modem, and dials your calls. It also lets you send and receive disk files and program up to 40 log-on codes and passwords on your computer's function keys. The program comes with a 70-page user's guide on disk. Although you must print the documentation yourself, it does provide all the help you need to begin communicating with other computers.

Qubie, \$299

RACAL-VADIC AUTO DIAL VA212

The Racal-Vadic Auto Dial VA212, or VA212PA, is a 103/212-compatible, direct-connect, RS-232 modem. This is a full-featured, intelligent device that belongs near the top of anyone's list of the best available modems.

The VA212PA comes with a User's Guide, a power cord, and a cable for plugging the modem

into the phone lines. You will also need a cable for connecting it to your computer. You can use the VA212PA without a phone, but you will find a built-in female connector for plugging a phone into the body of the modem.

The first thing you're likely to notice about this modem is its size. It is roughly a third again as wide as most modems. This extra width is needed because of the second thing you're likely to notice. The front panel is filled with control buttons. All told, there are 16 pressure sensitive switches. As with any intelligent modem, you can control the VA212LP through your keyboard or software. These controls give you a third option. If you're new to communications, you may find this push button control easier to use at first, and easier to understand.

The modem also has another peculiarity. It has nine status indicators, but only one status light. The other eight are labeled sections of an LCD display. When communicating with another modem, the VA212PA uses asterisks the way other modems use lights. When not communicating, it displays words. These serve two functions. Some messages keep you posted on the modem's mode or its progress in making a call. Other messages let you work interactively with modem. When controlling the VA212PA from your keyboard, the display reads "Terminal," and the modem sends its messages to your screen.

The modem has four operating modes: manual originate, manual answer, auto-answer, and auto-dial. It also has features that you won't generally find on modems. The auto-select dial mode, for instance, saves you from having to tell the modem to switch between pulse and tone dialing. Whenever the modem hears a dial tone, it tries one digit by tone dialing. If the dial tone is still there, it switches to pulse dialing. It will run this test each time it hears a dial tone, even in the process of dialing a single call.

Auto-select dial is merely convenient. Other features may be important. Among other things, the modem has the capability for synchronous as well as asynchronous communications. It also has its own memory. It can store up to 15 phone numbers of 31 digits each, and it will let you "link" numbers. If the first number is busy, the modem will automatically call the number it is linked to. This can be useful for calling through a network with more than one local number in your area.

One pleasant surprise is online help with commands. If you enter a "?" in response to a prompt, the modem will put a menu on your screen. Even nicer is that one of the commands will show you

the current settings for all 26 of the modem's options.

Another pleasant surprise with the VA212PA is the User's Guide. It is clear, well written, heavily illustrated, and will tell you precisely what you need to know, in the order you need to know it. The manual, in short, is as well designed as the modem itself.

And that is very well designed indeed.

Racal-Vadic, \$695

RACAL-VADIC VA212LC

The Racal-Vadic VA212LC is a relatively inexpensive 103/212-compatible modem. The low cost is a direct result of the modem's design. It offers few features beyond the choice of high speed or low speed communications. It will work at 1200 baud, and at all standard speeds between 0 and 300 baud.

The VA212LC is a direct-connect, RS-232 device. It comes with a User's Guide, a power cord, and a cable for plugging the modem into the phone system. You will also need a cable for connecting the modem to your computer.

Setting up the modem and learning how to use it should be easy enough even if you're completely unfamiliar with communications. This is only partly due to the simplicity of the modem. The User's Guide is far and away the best manual supplied with any of the common modems.

The VA212LC has two operating modes: Auto-Answer and Manual-Originate. It is permanently set to full-duplex, which means that if you need half-duplex, you'll have to make sure your software can provide it for you.

Like most direct-connect modems without auto-dial, the VA212LC is designed to go between the phone and the wall module: The phone plugs into the modem, and the modem plugs into the module. You can then use the phone as usual, or use it to dial a call for the modem's manual-originate mode.

There are two pairs of buttons on the front of the unit. One pair switches between high speed and low speed. A status light tells you which speed is in use at any given instant. The second pair of buttons switches between voice communications and data communications. Here again, a status light tells you the current setting. There are also three other status lights on the VA212LC. One indicates when the unit is communicating with another modem. The other two indicate when data is transmitted or received.

When the phone is hung-up ("on hook") and the modem is set for data communications, the

VA212LC is in its auto-answer mode. Anyone calling you will be greeted by the modem's strident squeal. To turn off the auto answer mode, set the unit for voice communications. In auto-answer, incidentally, you need not worry about the speed setting. The VA212LC will automatically set its baud rate to match the calling modem.

To use the modem's manual-originate mode, you set the speed, set the modem for voice communications, and establish the phone connection. Once you have a modem in answer mode on the other end of the line, you press the data button. The phone will go dead, and the carrier detect light will come on as the modems establish communications. When you're finished, you can simply hang up the phone, or you can go back to chatting by picking up the phone handset, and pushing the button labeled "voice." Either way, when you finish using the modem, be sure to reset it for voice communications unless you want it in auto-answer mode.

All this adds up to make the VA212LC a bare-bones simple, 103/212-compatible modem. It provides both low speed and high speed communications with few frills at a relatively low cost.

Racal-Vadic, \$495

RADIO SHACK TRS-80 MODEM IB

The Radio Shack TRS-80 Modem IB is a direct-connect, 103-compatible, RS-232 modem. It comes with an owner's manual, a power cord, and a permanently attached cable for connecting the modem to the phone lines. You will also need a cable for connecting the modem to your computer.

The IB gives you a choice of two ports for connecting the unit to your computer. Both of these are RS-232 ports, but one uses the more-or-less standard DB-25 connector while the other uses a Radio Shack-specific five-pin DIN connector. You'll find this five-pin connector on Radio Shack's Model I and on its Color Computer. Although this is still an RS-232 port, the cable for this connector may be somewhat cheaper. If you're using any other system, you can use the port with the "standard" connector.

Like most inexpensive direct-connect modems, the IB is meant to be installed between the phone and the wall module. The phone plugs into the modem, and the modem plugs into the wall. When the unit is off, you can use the phone as usual. When the unit is on, it cuts off the phone.

Using the Modem IB is simple. The unit has a single switch, for turning it on or off. There are two "on" positions: one for answer mode, one for orig-

inate mode. To use the modem, you only need to establish phone communications, then turn the modem on in either mode, as appropriate. As soon as you turn the modem on, the phone goes dead, and the "power on" light comes on. A second status light comes on soon after to confirm that the modems have established communications. When you're finished, you can either go back to voice communications by picking up the phone and turning off the modem, or you can simply hang up the phone by turning off the modem.

That's about it. The Modem IB is a good example of an entry level 103-compatible, direct-connect modem: It is inexpensive, it is easy to use, and it is extremely limited.

These three factors, of course, are intimately interrelated. The limitations designed into the modem are precisely what make it inexpensive and easy to use. This is fine if the modem can still fill your needs, but make sure that it can. Otherwise this inexpensive modem will wind up being an expensive mistake.

Most of the Modem IB's limitations are obvious enough, but two are both hidden and important. First, the IB cannot operate at any speed other than 300 baud, which means that you cannot use it for specialized networks like Telex I, Telex II or the deaf network. Second, it is permanently set to full-duplex. If you need half-duplex, you'll have to make sure your software can give it to you. Within these limitations, the Modem IB is perfectly adequate. It will give you dependable 300 baud communications in either of two modes: manual answer or manual originate.

The owner's manual for the IB is reasonably good by any standards. If you're a communications novice, you will find that it tells you what you need to know without unnecessary technical details. If you're technically more sophisticated, though, you may wish it had more information.

Radio Shack, \$99.95

U.S. ROBOTICS AUTO DIAL 212A

The Auto Dial 212A is a full-featured, 103/212-compatible, direct-connect, RS-232 modem. It shares nearly all the capabilities, and most of the commands, of the Hayes Smartmodem 1200.

The Auto Dial 212A comes with a user's guide, a power cord, and a cable for plugging the modem into the phone lines. You will also need a cable to connect the modem to your computer. You will *not* need a "Y" connector to connect a phone. Unlike most auto-dial modems, the Auto Dial 212A includes a jack for the phone in the body of the modem.

Because the capabilities and commands for this modem overlap so much with those of the Smartmodem, a comparison between the two is almost inevitable. Interestingly, there is no clear winner.

The most obvious difference between the two modems is in their looks. The Auto Dial 212A does not share the sleek design of the Smartmodem. To be honest, this is a clunky-looking device; if reviewers gave out awards based strictly on good looks, the Auto Dial 212A wouldn't even be in the running. On the other hand, someone had the good sense to put the on-off switch on the front panel. The switch on the Smartmodem is in the back, where it is impossible to reach without fumbling.

Differences in features also balance out fairly well. Both modems offer originate, answer, auto-answer, and auto-dial modes. The Smartmodem has a few commands available that you won't find in the Auto Dial 212A, but almost all of these represent arcane capabilities that most people will never use. You can, for instance, adjust the duration and spacing of touch tones with the Smartmodem. You cannot with the Auto Dial 212A.

Somewhat more important is the Smartmodem's reverse-dial mode. This will let you call another system, then automatically go into answer mode rather than originate mode. The Auto Dial 212A doesn't have this feature. On the other hand, it has a test mode, in which the modem will listen to itself. This lets you check out your system as a unit and can be more than a little helpful when trying to track down problems. You won't find this on the Smartmodem.

Probably the most important feature missing from the Auto Dial 212A is the ability to change settings while online. If you need to change duplex setting, for example, the Smartmodem will let you switch to command mode, change the setting, and go right back online. With the Auto Dial 212A, there is no way to do that without breaking the phone connection.

Most other differences are fairly subtle and relatively unimportant. The Auto Dial 212A has a jack where you can plug in a phone. With the Smartmodem, you have to buy a "Y" connector to get the same effect.

Other features on the Auto Dial 212A include a speaker and a bank of nine status lights. The speaker will let you monitor the progress of a call. In its default setting, it will come on when the modem picks up the phone and turn off when the modem establishes a connection or hangs up. Unlike the Smartmodem, the Auto Dial 212A does not have a volume adjustment for the speaker.

The status lights on the Auto Dial 212A serve nearly the same function as the lights on the Smart-

modem. The major difference is the one extra light, which indicates when the modem is in its test mode.

The user's guide for this modem, finally, is not one of the unit's strong points. It assumes a great deal of knowledge that you may or may not have. Consider this little tidbit from the installation instructions, listed under "Rear Dip Switches":

SHI = Pin 8 High

OFF = RS232 pin 8 clamped high

ON = RS232 pin 8 goes high and low with carrier detect

Great, but what does it *do*? (The manual for the Smartmodem is generally better, in case you're wondering, but not by much.)

All told, the Auto Dial 212A is a sophisticated device that is clearly in the same class with the Smartmodem. Ultimately, the Smartmodem may have a slight edge, but the Auto Dial 212A can still compete with it on a point for point basis, and do it at a savings of about \$100. This one is definitely worth looking at.

Compatibility: Any RS-232 port
U.S. Robotics, \$599

U.S. ROBOTICS PASSWORD

The Password is a full-featured, 103/212-compatible, direct-connect RS-232 modem. It shares all the commands and nearly all the capabilities of the U.S. Robotics Auto Dial 212A. In effect, it is a slightly stripped-down version of that modem.

The Password comes with a user's guide, a power cord, and cables for plugging into both your phones lines and your computer. This saves you the trouble of buying an RS-232 cable separately, but it means you have to buy the modem with the right cable in the first place. Or, more precisely, with the right connector. Password gives you three choices. You can get it with a 9-pin connector for the Osborne I or II, a female DB-25 connector for the IBM PC and its imitators, or a male DB-25 connector. These three connectors cover most, but not all, systems.

The most important difference between the Password and the Auto Dial 212A is that the Password doesn't have a bank of status lights. The single light on the front panel indicates whether the modem is on or off. Password lacks a Test mode, one of the 212A's more appealing features. Other differences vary from minor to trivial. The Pass-

word is smaller, a half-pound lighter, has a plastic case instead of a metal one, does not have a jack for plugging in a phone, and has had its on-off switch moved to the back of the unit. And one other thing. The Password is \$150 cheaper. Otherwise, the modems are essentially identical, as are the instructions in the user's guides. By any measurement, Password is a good modem. At the price, it's a dynamite value.

Compatibility: Any RS-232 port
U.S. Robotics, \$449

U.S. ROBOTICS S-100 AUTO DIAL MODEM

The S-100 Auto Dial modem is a full-featured 103/212-compatible, direct-connect, modem-on-a-board for S-100 systems. As the name implies, this modem shares most of the commands and capabilities of the U.S. Robotics Auto Dial 212A, just as the Password does. In fact, it's essentially identical to the Password.

The S-100 Auto Dial comes with a user's guide and a phone cable for plugging the modem into your phone lines. The modem slips into an S-100 slot inside the computer. The cable plugs directly into the modem. If you want to plug a phone in at the same location, you will need a "Y" connector for the wall module.

Features of the S-100 include originate, answer, auto-answer, and auto-dial modes. It can use full or half duplex, pulse or tone dialing, and can switch between pulse and tone dialing in midnumber. It also has a speaker mounted on the board, so you can follow the progress of a call being made.

As with other U.S. Robotics manuals, the user's guide tends heavily towards the technical. In this case, that tendency is amplified by the nature of the modem. To install it you have to "select a pair of addresses at the top or bottom of a group of sixteen which your computer does not already use." If you don't know what that means, you won't be able to do it.

If you have an S-100 system and a fair knowledge of how it works, this modem is certainly worth considering—particularly as an alternative to tying up an RS-232 port. If you don't have the technical background, however, or at least have a good friend who does, you're probably better off staying away from this one.

Compatibility: Any S-100 computer
U.S. Robotics, \$449

MODEMS

Manufacturer	Model	Protocols	Baud Rates	Computer Connection	Automatic Answer/Dial *	Dialing	Duplex	Price
Anchor	Volsmodem	103	300	RS-232 or through Atari game port	No/No		Full/half	\$80; \$13 for cable; \$40 for Atari cable
Bizcomp	1012	103/212A	110/300 1200	RS-232	Yes/Dial & repeat	Tone/pulse	Full only	\$549
	1022	103	110-300	RS-232	Yes/Dial & repeat	Tone/pulse	Full only	\$249
	2120	103/212A	110/300 1200	IBM PC board	Yes/Dial & repeat	Tone/pulse	Full only	\$499
Cermetek	Info-Mate 212A	103/212A	110/300 1200	RS-232	Yes/Yes	Tone/pulse	Full only	\$595
Hayes	Micromodem IIe	103	110/300	Apple II series, Apple III boards	Yes/Yes	Tone/pulse	Full/half	\$329
	Micromodem 100	103	110/300	S-100 Systems board	Yes/Yes	Pulse	Full/half	\$399
	Smartmodem 300	103	0-300	RS-232	Yes/Dial & reverse	Tone/pulse	Full/half	\$289
	Smartmodem 1200	103/212A	0-300 1200	RS-232	Yes/Dial & reverse	Tone/pulse	Full/half	\$699
	Smartmodem 1200B	103/212A	0-300 1200	IBM PC board	Yes/Dial & reverse	Tone/pulse	Full/half	\$599
Lexicon	LEX-11 and LEX-11B†	103	0-300	RS-232	No/No		Full/half	\$145 \$185
	LEX-12 and LEX-12B†	103	0-300	RS-232	No/No		Full only	\$165 \$205
MFJ	Acoustic	103	0-300	RS-232; TTL; CMOS; or through Apple II game port	No/No		Full/half	\$130
Microcom	ERA 2	103/212A	0-300 1200	Apple IIe, IBM PC, or PC jr. board	Yes/Dial & reverse	Tone-pulse	Full/half	\$499 (PC) \$399 (PC jr. and Apple)
Microperipheral	Autoprint Microconnection	103	0-300	Computer specific for VIC20, Commodore 64	Yes/Yes	Pulse	Full only	\$150
Novation	CAT Acoustic	103	0-300	RS-232	No/No		Full/half	\$189
	Apple-CAT II and A12 Apple-CAT II	103/202/ 212A	0-300 1200	Apple II series board	Yes/Yes	Tone/pulse	Full/half	\$389; \$725 with 212A

MODEMS (Continued)

Manufacturer	Model	Protocols	Baud Rates	Computer Connection	Automatic Answer/Dial *	Dialing	Duplex	Price
	J-CAT	103	0-300	TTL; some RS-232 ports	Yes/Yes	Pulse	Full	\$149
	103 SMART-CAT	103	110/300	RS-232	Yes/Yes	Tone/pulse	Full	\$249
	103/212 SMART-CAT	103/212A	110-300 1200	RS-232	Yes/Yes	Tone/pulse	Full	\$595
Racal-Vadic	VA212LC	103/212A	0-300 1200	RS-232	Yes/No		Full	\$495
	VA212PA	103/212A	0-300 1200	RS-232	Yes/Yes	Tone/pulse	Full	\$695
Radio Shack	Modem 1B	103	300	RS-232	No/No		Full	\$100
U.S. Robotics	Auto Dial 212A	103/212A	0-300 1200	RS-232	Yes/Yes	Tone/pulse	Full/half	\$599
	Password	103/212A	0-300 1200	RS-232	Yes/Yes	Tone/pulse	Full/half	\$449
	S-100	103/212A	0-300 1200	S-100 Systems board	Yes/Yes	Tone/pulse	Full/half	\$449

Note: All modems are direct connect, except for Lexicon's LEX-11 and 11B, MFJ's Acoustic, and Novation's CAT Acoustic, which are acoustically coupled. The Lexicon LEX-12 and 12B can be connected acoustically, through a headset jack, or directly.

* All modems have manual originate and answer modes, except for the Hayes Micromodem 100 and the Racal-Vadic VA212LC, which does not have manual answer.

† Indicates battery-operated version.

DISK DRIVES

What's a disk drive, and who needs one? Let's take a look at the answers to both of those questions right now.

When you use a computer to create something—a program, for example, or a document that you've written with a word-processing program—the program or text file that you've produced usually winds up stored in a special part of your computer's memory. This storage area is called random-access memory, or RAM. RAM is what makes it possible for computers to access data as rapidly as they do. Once a file of text or data has been tucked away in RAM, it can be retrieved almost instantly, usually at the touch of a few keys on a computer keyboard.

Unfortunately, though, RAM has a couple of characteristics that limit its usefulness. First, there's never enough of it available; a personal computer with a standard-size RAM capacity of 64K or so can store, or "remember," 20 to 30 or so double-spaced pages of text at any one time.

The other major limitation of RAM is that it isn't permanent. Computers, like people, can forget things quite easily. As soon as the power to a computer goes off—intentionally or otherwise—everything stored in RAM immediately disappears.

That, in a nutshell, is why most computers—or at least most computers that are used for more serious purposes than playing video games—are equipped with disk drives. Disk drives were invented so that computer data could be stored on magnetic disks, and could then be safely filed away.

Computer disks resemble phonograph disks, but work more like magnetic tapes. A computer disk, like an ordinary cassette tape, is a two-way recording medium: When a computer is hooked up to a disk drive, it can retrieve information that has been stored on the disk, and it can also store data on the disk, so that the information can be stowed away for safekeeping.

That makes a computer disk a very versatile storage medium. If you have a disk with a computer game stored on it (and many computer games do come on disks), you can load the data that's on the disk into your computer's memory, and play the game. If there's a word-processing program on the disk, the disk will automatically turn your computer into a word-processing program. If there's a spreadsheet (electronic ledger) program on the disk, then you can use that program. And so on.

If you ever decide that you want to learn to program and start writing programs of your own, then a disk drive will come in even handier. Then you can save your programs on a disk, and can load

them into your computer again and run them whenever you want to.

As useful as disk drives are, however, shopping for a disk drive can be quite confusing. Disk drives come in many shapes and sizes, and there are hundreds, if not thousands, of models to choose from. Fortunately, the disk-drive marketplace isn't nearly as difficult to sort out as it may appear at first glance. If you arm yourself with just a little basic knowledge about disks and disk drives, it really isn't so difficult to go shopping for a disk-drive system.

Before you begin your shopping trip, one of the most important things to know is just what a computer disk is. There are many kinds of computer disks, but most personal computers are designed to be used with 5¼-inch disks—sometimes called diskettes, floppy diskettes, or 5¼-inch floppies.

Floppy diskettes are made of pliable plastic coated with iron oxide. When computer data is to be stored on a disk, it is converted into minute magnetic impulses that are recorded on the disk's surface by a magnetic head in a disk drive. When information is retrieved from a disk, the magnetic impulses that have been "written" on its surface are "read" by the head in the disk drive. They are then converted back into computer data.

Before any data can be stored on a disk, however, the disk must be "formatted," or prepared to receive data. When a magnetic disk is purchased, it is usually completely blank. Before information can be stored on it, all of that empty space on it must somehow be organized, so that the disk-drive controller in a computer system will know where to put data on the disk, and how to find that data when it's needed later on.

When a disk is formatted, magnetic impulses are stored on it in an organized fashion, dividing the disk up into concentric circles called tracks and pie-shaped sections called sectors. At least one track is always reserved for a special file called a directory. Then later on, when other files are stored on the disk, the name and location of each file can be stored in the disk directory. Then, whenever file on the disk is needed, it can be found.

Disks are formatted in different ways by different computer systems. Some disks have more tracks than others do, and computers store disk directories and disk operating systems on disks in different ways. That's one reason that disks formatted for one kind of computer will often not work on a computer made by another company.

Another noteworthy fact about floppy disks is that when you buy them, they are enclosed in cardboard sleeves. They are never supposed to be re-

moved from these protective jackets for any reason whatever. The sleeves of floppy disks are permanently sealed, and they are designed to be kept on the disks at all times—even while the disks are spinning like records inside your disk drive!

How can a disk spin around inside its sleeve? That's easy. In the center of the sleeve that encloses a floppy disk, there is a cutout hole for a spindle—a rather large spindle, much like the one used in a 45-rpm record player. There's also a slot in the disk jacket, a little over an inch long, running from a point close to one edge of the jacket to a point not far from the center hole. This slot is called the head window. As the disk spins around in a disk drive, inside its cardboard sleeve, a magnetic head drops down and contacts the portion of the disk that is accessible through the head window. The head can then read the data that's stored on the disk, and can also erase information and write new data.

There are several kinds of 5¼-inch floppy disks—and several kinds of 5¼-inch disk drives. Most manufacturers of personal computers sell disk drives that are designed to be used with their machines. Many independent companies—most of which are mentioned in the mini-reviews that accompany this essay—also make disk drives. Rana, Micro-Sci, Percom, Tandon, and Control Data Corporation are just a few of the best-known independent manufacturers of disk drives.

A typical 5¼-inch disk drive—the kind most often used with most personal computers—can hold about 140K of data, or about 143,360 typed characters, or a little over 28,000 words. That works out to 50 to 60 single-spaced manuscript pages.

That may sound like a lot of storage space, but after you've been working with computers for awhile, you begin to realize how quickly you can run out of storage space on a standard 5¼-inch floppy. If you spend a lot of time at a computer keyboard, you can easily fill up a disk or two a day—and in a month's or a year's time, that can add up to a lot of disks. Furthermore, if you make a backup copy of every disk you use—and disks are so delicate that that is definitely a good idea—then the number of disks you use will double. Before you know it, you'll be neck-deep in 5¼-inch floppies.

Obviously, then, what this country really needs is a way to get more data on a disk. There are several ways to do it. One way is to use a special kind of high-density disk—a very high-quality disk that can hold more densely packed data, in much the same way that a fine-grooved LP record can hold more music than one with grooves that are larger.

Over the past couple of years, manufacturers of

computer disks have been introducing new varieties of exceptionally high quality disks that can hold more data than conventional disks. Actually, the data on a double-density disk is squeezed together electronically rather than physically; a complex electronic technique called multiplexing is used to increase the apparent density of the data. The result of this technique is the same as it would be if the data were actually packed closer together; thanks to multiplexing and high disk quality, some premium disks can be made to hold twice as much information as a conventional disk, or around 280K to 300K of data. These are therefore known, logically enough, as double-density disks. Now a few manufacturers have introduced quad-density disks, which can hold—you guessed it—four times as much data as an ordinary 5¼-inch floppy.

To make use of the increased storage capacity of a double-density or quad-density disk, it is necessary to use a specially designed double-density or quad-density disk drive. Conversely, to get the maximum benefit out of a double-density or quad-density disk drive, you have to use high-quality disks that are capable of storing densely packed data. Over the past couple of years, plenty of double-density disk drives have been introduced; in fact almost every manufacturer of floppy-disk drives has at least one double-density disk drive in its line.

Quad-density drives are considerably harder to find—as are quad-density disks. That's probably because quad-density disks are pushing the outer limits of the storage capabilities of the floppy-disk medium. Most quad-density disks can store a little over 500K of data on one side of a 5¼-inch disk, and some can store even more. About the highest capacity quad-density drive introduced to date is the Rana 2.5 Super Floppy Disk System, which can store an incredible 2.5 megabytes of data—that's 2.5 million bytes—on one quad-density, double-sided 5¼-inch floppy.

That brings us to another method for increasing the storage capacity of a disk—recording data on both sides. It's easy enough to do, if you don't mind turning the disk over every time you want to access a piece of data on the other side. But suppose you're working with a long file, one that takes up both sides of the diskette. How can you merge, sort, and otherwise manipulate a file like that on a two-sided disk, without messing things up terribly?

Well, you can't. Not unless you have a specially designed double-sided disk drive.

A double-sided disk drive—one specifically designed to read and write two-sided disks—usually has two recording heads, one facing each side of

the disk. Those heads are usually controlled with "intelligent" circuitry that can automatically keep track of where each head is and where each bit of data is at every moment, automatically managing all of the files on the disk so that you never have to worry about which side of the disk your data is stored on.

There are also several other methods that are now being used to increase the amount of data that can be stored on a disk. One technique that has now become quite popular is—believe it or not—the use of smaller disks.

There is nothing intrinsically better, of course, about a smaller disk. Manufacturers of disks and disk drives have been able, over the past couple of years, to combine the concept of a smaller disk with the concept of a better disk. They have been able to do that not so much by improving the quality of the disk itself as by improving the quality of the jacket in which the disk is enclosed.

As previously mentioned, 5¼-inch floppy disks are permanently sealed into cardboard sleeves with slots in them, and spin around inside those sleeves when they are inside a disk drive. Obviously, this is not exactly a high-precision method for storing or retrieving computer data. Every time a disk spins around in its cardboard sleeve, the disk rubs against its jacket and part of its thin magnetic coating wears away. If a finger accidentally touches the surface of the disk through the head window in its jacket (and that happens quite often), the grease deposited by a fingerprint can actually destroy data. If a ballpoint pen is used to fill out a disk label, the pressure of the pen against the disk inside its sleeve can ruin the disk or wipe out some data.

Since the thin jackets around 5¼-inch disks make them so vulnerable to damage and destruction, disk designers decided some time ago that the sleeves in which floppy disks were enclosed had to be improved. So, as engineers worked to develop smaller, more compact computer disks, they also labored to find a better disk housing. In both of these efforts, they have succeeded admirably. Two compact-disk formats—a 3-inch format and a 3½-inch format—are now competing for acceptance in the computer-disk marketplace. Both types of mini-disks have higher data-storage capacities than 5¼-inch floppies have, despite their small size. Both types of disks are enclosed in hard plastic jackets that are much more protective than thin cardboard. And the more popular of the two formats—the 3½-inch format—has a head window that remains snapped shut until the disk is safely in place inside a disk drive.

The 3½-inch disk format was developed by Sony and is now being used in the Apple Macintosh, the Apple Lisa, and the Hewlett-Packard HP-150. The 3-inch drive was developed by Hitachi, in cooperation with Matsushita and Maxell, and is now being used by Amdek and a few other disk-drive manufacturers.

The microfloppy disk drive now being used in the Apple Macintosh uses a single-sided 3½-inch disk with a storage capacity of 400K. Double-sided disks with total storage capacities of 800K may be used in future Macintosh models. Sony says that its 3½-inch disk can now store 1 megabyte of unformatted data, and will eventually offer 2 megabytes of storage space in a double-sided mode.

Three-inch microdisks are now being marketed mainly in Japan, and Matsushita, one of the three companies that pioneered the format, is now also manufacturing 3½-inch drives. Double-sided, double-density 3-inch disks have been introduced in both this country and Japan, and Maxell says that a 1-megabyte 3-inch disk will be unveiled soon.[∞]

HARD-DISK DRIVES

There's one other kind of disk that many computer owners use—a hard disk, or a Winchester disk. Winchester disks are made of metal coated with a magnetically sensitive oxide, and they spin at 3,600 RPM, for a standard 5¼-inch floppy.

Winchester disks were not invented by an engineer named Winchester, nor were they developed by a company with that name. According to computer lore, one early model of a hard-disk drive was a 30-megabyte unit with a 30-megabyte backup, and was dubbed a Winchester disk because of its "30-30" design.

Although rotating at 3,600 RPM could hardly be called standing still, Winchester disks are also sometimes called fixed disks. That's because most of the platters used in hard-disk drives are so sensitive to dust and dirt that they're permanently sealed into their disk drives, and are never supposed to be removed by the user. So unless you become a disk-drive repairer, chances are that you'll never see the hard disk in a fixed-disk Winchester drive.

That doesn't mean that every hard-disk drive has a nonremovable platter, however. A few companies—Genie Computer Corporation, to name one—do manufacture hard-disk drives with removable platters. These platters are sealed inside plastic cases so that dust and dirt can't harm them.

The storage capacities of hard-disk drives range from 5 megabytes or so to 70 megabytes and more. The QuadDisk, manufactured by the Quadram Cor-

poration of Norcross, GA, has an incredible 72-megabyte data-storage capacity.

One serious problem occasionally arises when information is stored on a hard disk with a giant-size storage capacity. Although most good Winchester drives are ruggedly built and loaded with features to prevent data loss, accidents do happen, and a hard disk does from time to time bite the dust. If just a little data is lost when that happens, the results are not devastating. But some hard-disk crashes can result in many megabytes of data loss, and that can spell disaster.

So what's a computer user to do? Back up hard disks, that's what. And there are a number of ways to back up hard-disk data.

Some hard-disk drives, such as the Apple ProFile drive, come with software programs that can be used to copy all of the information stored on a hard disk onto 5¼-inch floppies. Other companies, such as Tallgrass Technologies and Space Coast Systems, manufacture hard-disk backup systems that use tape cassettes as backup media. Still other companies, such as Genie, suggest that fixed hard disks be backed up with removable hard-disk cartridges.

Some backup systems are faster and easier to use than others, but when disaster strikes, it is better to have used some backup system than to have used none at all. It's user's choice, but it's definitely a good idea to use some kind of backup system when you own a hard-disk drive.

AMDEK DISK DRIVES

Amdek, a company best known as a manufacturer of computer monitors, now also offers a line of compact disk drives. Drives manufactured by Amdek include the Amdisk-V, a half-height 5¼-inch unit that takes up only half the space of a conventional disk drive; the Amdisk-I, an Apple-compatible 3-inch microdisk drive with a formatted storage capacity of up to 286K; the Amdisk-III, a 3-inch dual-disk drive designed for use with Radio Shack Color Computers; and the AMDC-I and AMDC-II, a single-drive microdisk unit and a double-drive microdisk unit designed for use with Atari home computers.

The Amdisk-V is exactly half the height of a conventional disk drive, so two Amdisk-V modules can be slipped into a space designed to hold one conventional drive—for example, one of the two disk-drive slots that are built into the IBM computer. But the recording format, data transfer rate, and disk rotation speed of the Amdisk-V meet all normal specifications for single-disk drives. The unit comes in two models: a single-density version with

a storage capacity of 250K, and a double-density storage capacity of 500K.

Amdek's Amdisk-I microfloppy-disk drive uses pocket-sized three-inch disks but is compatible with the standard 5¼-inch Apple Disk II drive. The unit measures 3.74 inches high by 1.77 inches wide by 6.02 inches deep, and is designed to be interfaced with an Apple disk controller card via a standard 20-pin flat connector. It can store up to 143K of formatted data on one side of a 3-inch disk, and each disk can be flipped over to provide another 143K of storage on the other side. The suggested retail price of the Amdisk-I drive is \$299.

The two-disk Amdisk-III microfloppy drive provides a total storage capacity of 624K when it is connected to a Radio Shack Color Computer. It is completely compatible with TRS-DOS, Radio Shack's disk operating system, and also supports the higher-performance Flex operating system. The Amdisk-III uses miniature 3-inch diskettes, and has a faster data-access time than that of conventional 5¼-inch drives.

The single-drive AMDC-1 and the dual-drive AMDC-II both come with an intelligent controller that is compatible with all Atari computers, including those in the Atari XL series. Each system also includes a built-in power supply, a DOS/XL (formerly OS/A+) operating system, and a 90-day parts-and-labor warranty. The AMDC-II provides a total of 360K of on-line formatted storage capacity, and each disk can be flipped over for a total storage capacity of two disks of 720K.

Amdek, Amdisk-V \$658; Amdisk-I \$299; Amdisk-III \$499; AmDC-I \$550; AmDC-II \$760

APPARAT HARD DISK SUBSYSTEM

If you want to convert your IBM PC to an XT, you might consider the Apparat 10 Megabyte Hard Disk. This disk is mounted in an external cabinet so, although your system won't look like an XT, it will act like one. The PC will boot directly from the Apparat disk. No device drivers or DOS patches are necessary.

The system consists of an external cabinet, an interface board called the HIM (Host Interface Module) to plug into your PC, cables, one floppy diskette and manuals. The external cabinet contains the disk drive, a Xebec hard disk controller and a power supply. The HIM board contains the interface to the hard disk, the Fixed Disk BIOS (FDBIOS) (which resides at C8000H to C8FF0H) and the bonus of an RS-232 serial port. A PROM is also provided to replace the ROM in U33 if you have the

older 64K motherboard. If you have the newer 256K capacity system board this chip is not required.

The documentation is rather skimpy (13 pages), but installation is simple and you are advised to call Apparat for technical assistance if you experience any problems.

Apparat claims that this system emulates the XT hard drive perfectly. To accomplish this, many vendors of hard disks are forced to include special software drivers and other routines. Apparat includes only two special software routines. The first is *PARK.EXE*, which removes the heads from the data area before moving or shipping the disk. The second is *HDINIT.EXE*, which performs a factory formatting of the disk. You won't need to use this second program unless you get an error while running the DOS 2.0 *FORMAT* command.

A common problem with this system is a strange slowdown when it is used with a multifunction card installed in the PC. It appears that there is some incompatibility between this card and Apparat's controller card. Switching the positions of the cards solves the problem. Apparat is investigating the situation to determine why this is so. Until then, if you have any problems, try swapping cards or call Apparat at (800) 525-7674. Their technical department seems very knowledgeable and ready to help.

If you want to add a hard disk and need IBM fixed disk compatibility, the Apparat system appears to be an excellent choice. It is available with disk capacities of 5, 10, 15 and 26 megabytes.

Apparat, 5mb \$1,796; 10mb \$1,995; 15mb \$2,495; 26mb \$3,395

THE APPLE DUODISK DRIVES

You can save money as well as space by purchasing the Apple Duodisk drive, a slimline two-drive module that costs less than two single-disk Apple drives.

The Duodisk is an attractive, low-profile unit that contains two half-height 5¼-inch floppy-disk drives. It is designed to be placed on top of an Apple II, II+, or IIe computer, and a video monitor can be stacked on top of it. The Duodisk unit is just the right size, shape, and color to be used in such an arrangement, and when it is combined with an Apple II-series computer and an Apple Monitor II, the result is an integrated, uncluttered appearance that can make an Apple system look very good.

More important, the Duodisk offers a total disk storage capacity of 180 kilobytes (unformatted) for a suggested retail price of \$795, compared with a

list price of \$940 for two standard Apple Disk II drives. The Duodisk is completely compatible with Apple's Disk II drives, of course, as well as with the Apple ProFile hard-disk drive. It also offers several technical improvements, including a new mechanism for ejecting disks and an advanced, more precise head-positioning mechanism.

Apple, \$795

THE APPLE PROFILE HARD-DISK DRIVE

Apple now makes a hard-disk drive for its Model II+ and IIe computers called the ProFile system. This review was written on an Apple IIe computer equipped with a ProFile drive, and many other reviews—along with several books and dozens of magazine articles—have been written on the same computer system. Not one component in the system—including the ProFile drive—has ever given this reviewer a speck of trouble.

After one has lived with a system for a while, however, one does begin to get familiar with its flaws. For example, the Apple ProFile does not run as quietly as some hard-disk drives do, and it doesn't have as much storage capacity as some hard-disk systems. But its price is relatively modest for a hard-disk drive, and it's a solidly constructed unit that appears to have been built to Apple's usual high quality standards. Most important, perhaps, it's tailor-made to be used with ProDOS, the new disk operating system that Apple is now using in its II-series computers.

The ProFile is 5-megabyte disk drive, with a storage capacity equivalent to that of about 35 standard 5¼-inch floppy disks, or about 1,200 single-spaced typewritten pages. According to Apple, its data-access speed is about 10 times as fast as the data-access rate of a conventional floppy-disk drive.

The ProFile drive contains a 5¼-inch hard disk and disk transport system sealed into a lightweight, light tan cabinet approximately 17 inches wide, 9 inches deep, and 4½ inches high. The unit is designed to be connected to an Apple II, II+, or IIe computer via a plug-in disk-driver card and a special cable, both of which are supplied with the drive.

The controller card that comes with the ProFile drive cannot be used with the new Apple IIc portable computer, since the Apple IIc does not accept plug-in circuit cards. At the time this review was written, Apple had not announced any plans to introduce an Apple IIc-compatible hard-disk drive.

The ProFile disk drive comes with a disk called a *Pascal ProFile Manager*, and a Pascal ProFile Man-

ager Manual. With this package, the owner of an Apple II-series computer equipped with a ProFile system can store and retrieve programs written in Pascal using the ProFile drive.

Another software package that comes with ProFile is a disk-based program called *Backup II*. The *Backup II* package provides a relatively fast and easy system for making floppy-disk backups of files stored on a ProFile drive. The *Backup II* system can be used either to copy a complete hard-disk image onto 5¼-inch floppies, or to copy only those files that have been changed since the last backup copy of the disk was made.

The Apple ProFile hard-disk drive was originally designed to be used with the Apple III, a business-oriented computer that uses a disk operating system called the Sophisticated Operating System, or SOS. ProDOS, the disk operating system now being shipped with all Apple IIe and Apple IIc computers, is a scaled-down version of SOS, so it was probably not very difficult for Apple to design a version of the unit that would be compatible with the Apple II, II+, and IIe.

ProDOS is extremely well suited for use with a large mass-storage medium such as ProFile, since ProDOS does not maintain any records of the physical locations of disk drives, but instead groups files into divisions called volumes. Each volume can be subdivided into divisions called pathnames. A pathname can be further subdivided, and its subdivisions can also be subdivided, at the option of the user, using as many levels of subdivisions as desired. Once a block of information has been divided into as many subdivisions as are needed to identify it, it becomes a file. The length of a file can range from one byte to 16 megabytes in the ProDOS system. So the ProDOS system has a much larger file-handling capacity than the ProFile drive.

The ProFile drive can be used with any Apple II, Apple II+, or Apple IIe computer with an internal memory capacity of 64K or more. The unit is completely compatible with Apple Disk II and Duodisk floppy-disk drives.

Apple, \$2,200

BERNOULLI BOX

If you need mass storage, convenient backup and archival storage for your IBM PC, the Iomega Bernoulli Box may be just what you want. The Bernoulli Box was named after Daniel Bernoulli, an 18th-century mathematician whose work in fluid mechanics resulted in Bernoulli's Law. The Bernoulli Box is an 8-inch, 10-megabyte cartridge disk

drive based on this law. Using a single-sided flexible disk in a hard plastic cartridge, the performance of the Iomega drive rivals that of a Winchester hard drive.

The Bernoulli Box is styled to complement the IBM PC and is available with either one or two 10-megabyte drives. The two drive system is preferable—it allows backup to be done by simply inserting a cartridge and copying from one drive to the other. Anyone who has done a full backup from a hard disk to floppy disks can tell you how much time and how many floppy disks it takes to backup 10 megabytes.

The cartridge system is an excellent value for a system that has more than one user who needs a large amount of storage. Security is also enhanced. There's no need to worry about anyone deleting your files or having to use elaborate encoding schemes that block access to them.

Hooking the system into your PC is easy. You must boot from your floppy drive to load the necessary device drivers, but after that it acts like any other hard disk system. The system is faster than many hard disk add-ons—its transfer rate is one megabyte per second and its average seek time is 35 milliseconds.

If you like the idea of a removable 10-megabyte flexible disk with the performance of a hard disk, the Iomega Bernoulli Box is something you should consider.

Iomega Corp., Two 10mb drives \$3,695; one 10mb drive \$2,695; 10mb disk cartridge \$45

COMREX DISK DRIVES

Comrex has two new disk drives in its line: the Cr-1000 ComDrive, a low-profile 5¼-inch dual-drive system for Apple computers, and the ComFiler, a 10-megabyte hard-disk drive designed to be used with the Epson QX-10.

Comrex's Apple-compatible floppy-disk drive, the CR-1000, is a low-profile unit containing two half-height 5¼-inch drives mounted side by side. It is a single-sided, single-density unit which offers a formatted data-storage capacity of 143K per drive, or a total of 286K. It has a density of 48 tracks per inch, and a seek time 40 milliseconds.

The CR-1000 is a handsome unit that appears to be sturdy and well designed. It can be placed on top of any Apple II-series computer, with a video monitor stacked on top of it, resulting in an attractive, compact, desktop computer system.

The Comrex ComFiler hard-disk drive offers owners of the Epson QX-10 computer 10 megabytes (formatted) of fast-access storage capacity.

The ComFiler is completely compatible with both the Epson QX-10/VALDOCS disk operating system and CP/M 2.2, and it allows VALDOCS and CP/M software to be stored on the same hard disk. So the ComFiler can provide the Epson user with fast and easy access to a wide range of software.

The ComFiler drive has a data-transfer rate of 5 million bits per second, and a track-to-track data-access time of 3 milliseconds. It comes with a hard-disk controller and an Epson QX-10 interface. It measures 7.8 inches wide by 5.7 inches high by 14.8 inches deep, and it weighs 17 pounds.

Comrex, CR-1000 \$599; ComFiler \$2,295

CONTROL DATA DISK DRIVES

Back in 1959, Control Data Corporation stopped trying to buy peripherals for a line of scientific computers that it was manufacturing, and decided to start producing its own. Soon the company discovered that there was a tremendous and growing demand for high-quality computer peripherals, particularly mass-storage peripherals such as floppy-disk and hard-disk drives. Today, Control Data is one of the world's largest manufacturers of data-storage equipment. Some of the company's drives are sold at retail, but most of them go into OEM (Original Equipment Manufacture) sales channels; Control Data supplies many of the world's leading computer and peripheral manufacturers with disk drives.

The 5¼-inch floppy-disk drives in the Control Data family range from the Model 9408, with 125K of storage capacity, to the Model 9429, with 1 full megabyte of storage. Control Data also makes a line of 5¼-inch hard-disk drives called the Wren series, and a line of 8-inch fixed-disk/removable-disk systems called the Lark series.

The drives in the Wren series have storage capacities ranging from 21.77 megabytes to 85.96 megabytes. And the units in the Lark series have literally unlimited storage capacities, since they have built-in fixed disks and also accept removable hard-disk cartridges. The capacities of the fixed disks used in the Lark series have capacities ranging from 8.35 megabytes to 25 megabytes, and the capacities of the removable cartridges used in the drives are identical to those of the fixed disks. The total storage capacities of the disk drives in the Lark series therefore range from 16.7 to 50 megabytes.

Control Data Corp., price to be determined by dealer

CORONA STARFIRE 10 HARD DISK

The Corona Data Systems Starfire 10 is a small (15 inches by 8.5 inches by 6 inches), attractive Winchester disk unit for the Apple II or IIe computer with 48K RAM and at least one floppy disk. It offers approximately 10 megabytes of storage when formatted and is 10 or more times as fast as floppy disk drives. Its large interface card plugs into one of the Apple's peripheral slots and contains on-board ROM-based software. This allows the Starfire to work with software that requires all of the Apple's main memory.

Physical installation of the drive is simple: plug the interface card into the Apple, route the drive's thick cable around the inside of the Apple, plug the cable into the interface board, and connect the cable's ground wire to a separate post on the interface card. The only difficult part of this operation is routing the cable. The connector will only fit through the leftmost opening on the Apple IIe. Even with this slight difficulty, installation of the Starfire on the Apple IIe takes less than 15 minutes. It is somewhat easier to route the thick cable on the Apple II, which has large vertical openings in the back. Even with this slight difficulty, installation of the interface card and mounting the cable took less than 15 minutes. Corona recommends that the interface card be installed in slot 7. This allows the Apple to boot from the floppy in slot 6 if the Starfire is turned off from the hard disk or if it is turned on before the Apple is powered up.

The Starfire comes with an enhanced Apple DOS 3.3, patches that enable CP/M 2.2 and Pascal to utilize the hard disk, a supervisor program that brings up the available operating systems and various utilities that format and manage the hard disk. CP/M and Pascal are not provided—the user must supply a Microsoft CP/M card and CP/M 2.2 to run CP/M and the Pascal operating system to run Pascal. The Starfire's supervisor allows all three operating systems to reside on the same physical drive. To do this, drive is then segmented into different operating system areas, each of which may contain a number of virtual drives.

One problem with using a hard disk on the Apple is that Apple's DOS 3.3 does not allow for a disk volume larger than 440 sectors (the size of a floppy disk). Although it is not included in the Starfire package, Corona supplies an enhanced version of Apple's DOS called DOS 3.3+ which allows extended volumes of up to 1600 sectors.

The Corona Starfire 10 is an excellent unit. It offers significant improvements in speed, capacity and utility. The only problem with it is common to all hard disk add-ons—backing up 10 megabytes

onto 143K floppy disks is a major project. Corona provides a backup and restore utility, but you may wish to invest a few dollars more in an incremental backup utility. This allows you to backup only those files which have changed since the last backup, a much less time-consuming task.

Rana Systems, Inc., \$14.95

CORVUS HARD-DISK DRIVES

Corvus, the world's leading manufacturer of local-area computer networking equipment, has introduced a whole new generation of hard-disk drives designed to be used in networking applications. The new units are the first disk drives to be specifically designed for use with personal-computer networks.

Corvus is the originator of the widely-used Omninet local-area computer networking system, and is the principal supplier of equipment used in Omninet systems. An Omninet system allows personal computers to operate together over distances of up to 4,000 feet. The new Corvus disk drives, called OmniDrive systems, were designed to be used both in computer networks using Omninet and by single-computer systems. When the drives are used in single-user systems, they can provide stand-alone computers with access to any Corvus Omninet computer network.

The new Corvus drives have data-storage capacities ranging from 5.5 megabytes to 45.1 megabytes. The cost of the drive systems do not include Constellation II software, which must be used in Omninet systems, or startup accessories that are needed to adapt the drives for use in stand-alone systems. So extra hardware and accessories can add from \$100 to \$1,000 to the cost of each OmniDisk system, depending upon the user's needs. But the new drives eliminate the need for a \$1,000 device called an Omninet disk server, which was previously required in Omninet network systems.

The OmniDrive systems can be used with the Corvus Concept computer, Apple II-series computers, the DEC Rainbow 100, the IBM Personal Computer and PC XT, the Texas Instruments Professional, and the Zenith Z-100.

In addition to its OmniDrive systems, Corvus also manufactures stand-alone hard disk drives that range from 6 to 18 megabytes each in data-storage capacity and are designed to be used with Apple II-series computers, Apple III-series computers, and the IBM PC.

Corvus, 6 megabytes \$1,995; 11 megabytes \$2,495; 16 megabytes \$3,195; 45 megabytes \$4,995

DAVONG HARD DISK SYSTEMS

A complete line of add-on hard disks with storage capabilities from 5 to 32 megabytes is available from Davong Systems. The drives are available for use with the Apple II, IIe, or III or the IBM PC.

For the IBM PC, you can choose between a drive in an external cabinet or an internal drive with an external power supply. Both drive systems include Davong's Multi-OS operating system, which allows DOS, UCSD Pascal, CP/M-86 and Concurrent CP/M to reside on the same hard disk.

The 10-megabyte internal system for the IBM PC consists of the disk drive, an external power supply, a controller card, cables, and Multi-OS operating system diskettes. You should have no problems installing the drive. You may want to study the Multi-OS Users Guide before configuring your disk to take advantage of all the many capabilities it offers.

With Multi-OS you can divide your disk into a number of "volumes." The maximum size of a volume is limited by the space available on the disk and by the operating system. You can choose any mix of volume sizes that you may require.

Multi-OS allows a password to protect a volume or a boot diskette from unauthorized use. You can also assign individual and group access rights so that various users can be limited to read-only, write-only, read/write or no access.

The manual includes information for using Multi-OS with the Compaq, Eagle or Columbia computers. However, you must use IBM's PC-DOS, and program patching may be necessary. If you own an IBM-compatible you should check with your dealer or with Davong before buying.

Davong offers a Streaming Tape Backup drive to back up either Davong Hard Disks or the IBM XT. The Davong MultiLink local area network is also available. Multi-OS is available separately for use with the IBM XT.

Davong Systems, External hard disk with IBM or Apple adaptor: 5mb \$1,995, 10mb \$2,395, 15mb \$2,795, 21mb \$3,295, 32mb \$3,995; Internal hard disk, IBM adaptor and power supply: 5mb \$1,845, 10mb \$2,095, 15mb \$2,695, 21mb \$3,095, 32mb \$3,695

GENIE REMOVABLE-PLATTER HARD-DISK DRIVES

Who said you can't change a hard disk? Well, you can be sure that Genie didn't. You see, Genie Computer Corporation makes hard-disk drives with disks that you *can* remove—and change. That

gives Genie's removable-disk Winchester drives a literally unlimited amount of storage capacity.

Genie also manufactures hard-disk drives with disks that are not removable. The company's fixed-disk drives can be used together with its removable-disk drives. Genie disk drives are compatible with IBM Personal Computer and the PC-XT; the Apple IIe; the Texas Instruments Professional Computer; the DEC Rainbow; most computers that use the S-100 bus; and the Tandy (Radio Shack) TRS-80 computer line.

There are two removable-disk drives in the Genie line. One, the Model X5A, stores information on a removable 5¼-inch hard disk. The disk has a formatted storage capacity of 5 megabytes—about the same capacity as 30 conventional 5¼-inch floppies. The hard disk is sealed inside a sealed plastic case that is a quarter of an inch thick and can easily be held in one hand. When this disk cartridge is slipped into the X5A drive module, it seats itself behind a sliding door that can be opened only by the drive. During operation, the disk is thus kept where it should be: away from human hands.

When the disk has been filled to capacity, however, another disk can be used. That gives the Genie X5A drive an unlimited data-storage capacity.

Another Genie drive, the Model 5+5, contains a fixed 5-megabyte hard disk that can be supplemented with a 5-megabyte removable disk, for a total data-storage capacity of 10 megabytes. The combination of a removable disk and a fixed disk makes the Genie 5+5 much more versatile than the Genie X5A; when the Model 5+5 is used, data that has been stored on the fixed disk and is no longer needed can be transferred to the removable disk and then filed away for safekeeping. Removable disks can also be used to back up the fixed disk very quickly and easily; it takes only about 90 seconds to back up 5 megabytes of data using a Genie removable-disk drive.

The X5A disk drive has a list price of \$3,295. The Model 5+5 retails for a suggested \$3,995. The removable disk packs used in Genie drives retail for \$159 each.

Genie also manufactures four drives that contain fixed disks and cannot be used with removable disk packs. However, all four can be used in tandem with either the Model X5A or the Model 5+5, and can thus take advantage of their removable-disk feature.

The Genie product line also includes a cartridge tape backup module called the Jetstreamer 20/40. The Jetstreamer can back up a 20Mb hard disk on a quarter-inch tape cartridge in four minutes.

Genie's fixed-disk drives that do not use removable disks are the 5Mb Model 5F, the 10Mb 10F, the 15Mb 15F, and the 20Mb 20F.

All of Genie's disk-drive systems have a data transfer rate of 5 million bits per second. The X5A and the 5+5 have a track-to-track data access time of 2 milliseconds, but Genie's other models have a track-to-track data access time rated at 3 milliseconds.

Other special features of Genie disk drives include a spindle and heads that lock into a safe position when the power is off to guard against data loss and disk damage, a servo system for accurate head positioning and disk speed, and a carefully designed closed air circulation system to keep pollution out away from hard disks and out of the disk drives.

Genie, Model X5A \$3,295; Model 5F \$2,295; Model 10F \$2,595; Model 15F \$2,895; Model 20F \$3,195; Jetstreamer 20/40 \$1,995

INDUS GT DISK DRIVE

There are some very obvious differences between an Indus GT disk drive and most of the other 5¼-inch disk drives that you see in computer stores. Indus GT drives come in sleek, shiny cabinets, and they run with the quietness of a whisper while bright LED numbers on the front panel help you monitor the state of the disk that whirls around inside. And what you see is not all you get when you buy an Indus GT. You also get three disk-based software packages—and a carrying case that can double as a storage cabinet for up to 100 diskettes!

And all of those extras don't cost an extra-big price. It's available in versions that can be used with Apple II-series computers, Atari computers, the Commodore 64 and VIC-20, and the IBM PCjr. The drive is designed to be used with single-sided disks. Data storage capacity ranges from 143K for the Atari-compatible model to 360K for the version designed for PCjr.

The LED numbers on the front panel of the Indus GT can keep you informed about many of the mysterious things that go on inside a disk drive. It can tell you what track is being recorded on, and if something goes wrong during a disk operation, it can give you a numbered error message letting you know what has happened. The LED display can also be programmed to provide you with other useful information, such as what I/O control buffer is occupied by your drive (if you're using the drive with an Atari computer) or what device number your disk drive is (if you're using it with a Commodore).

The software package that comes with the Indus GT contains a word processor, a spreadsheet program, and a database manager. The three programs aren't in the class of *WordStar*, *SuperCalc*, or *dBase II*, but they aren't bad—and the price is certainly right! And even without them, the Indus GT is quite a disk-drive system.

Indus, Atari \$485; Apple \$355; Franklin \$430

MAYNARD HARD-DISK DRIVES

You get more than 10 megabytes of disk storage when you buy a Maynard hard-disk drive system for your IBM Personal Computer. You also get a plug-in circuit card that can add extra RAM, additional input-output capabilities, and a number of special functions to your PC.

The Maynard hard-disk drive is an extremely high quality Winchester system with a formatted storage capacity of 10 megabytes and a suggested retail price ranging from \$1,395 to \$1,595, depending upon the type of disk-driver card you select. Three different disk-driver cards are available, and each one offers a different selection of features.

In addition to supporting the Maynard hard-disk drive, the SandStar Multifunction card allows you to add up to three other SandStar plug-in cards to your IBM PC while using just one card slot. Cards that can be plugged into the SandStar Multifunction card include a serial-port card, a parallel-port card, a clock-and-calendar card, a game adapter, and other types of special I/O cards.

You can buy a Maynard hard-disk drive equipped with a SandStar floppy-disk controller card. With this card, an IBM PC can be interfaced not only with a hard-disk drive, but also with two floppy-disk drives mounted inside the computer—and, optionally, two more 5¼-inch or 8-inch floppy drives mounted externally. This card, like the SandStar Multifunction card, can save a considerable amount of card-slot space inside an IBM PC.

The third controller card that is available with the Maynard hard-disk system is called the SandStar Memory Card. In addition to controlling the hard-disk drive, the SandStar Memory card can add 64K to 576K of RAM to an IBM PC, using only one card slot.

The Maynard hard-disk drive is an attractive, ruggedly constructed unit that is designed to match the IBM PC cosmetically as well as technologically. Special features of the Maynard hard-disk system included a plated platter designed for high reliability at high bit density; a microprocessor-controlled servo system for fast and accurate track-to-track data access; a highly advanced, thermally insu-

lated stepper motor; embedded guard bands to guard against head crashes; low power requirements; and a sophisticated on-board self-diagnostic system.

Maynard, With SandStar Multifunction card \$1,395; with SandStar floppy-disk controller card \$1,595; with SandStar memory card \$1,595

MICRO-SCI DISK DRIVES

Micro-Sci was the first company to build a floppy-disk drive for the Apple II computer that had more storage capacity than Apple's own drive. Today Micro-Sci also manufactures a number of other computer products, but the company has sold more than 75,000 disk drives to Apple users, and is still best known as a manufacturer of Apple-compatible floppy-disk drives.

Two of Micro-Sci's newest Apple-compatible drives are the Model XL and the Model XL80. The Micro-Sci XL is a 40-track drive with a storage capacity of 164K, compared with a capacity of 143K for Apple's standard 35-track Disk II Drive. The Micro-Sci XL80 is an 80-track, double-density drive with a 328K storage capacity.

Micro-Sci says that its XL and XL80 were designed for budget-minded Apple owners who want quality as well as economy. Up to now, the company says, the frames and doors of 5¼-inch drives have usually been made of expensive machine aluminum. "But through careful research," the company continues, "Micro-Sci engineers found that simple sheet metal, when bent and formed accurately, provided all the strength necessary for the main frame." So the frames of Micro-Sci's XL and XL80 drives have been constructed out of sheet metal without any sacrifice in quality, the company says. The doors and cases of the drives are molded from high-impact plastic, for more savings with no decrease in quality standards, according to Micro-Sci.

That may sound like nothing but a defense for making disk drives out of cheap materials, but it does have the ring of an honest statement. Micro-Sci's XL and XL80 disk drives appear to be just about as sturdy as one has a right to expect a disk drive to be. On the inside, where quality really counts, there is certainly no visible evidence of any skimping on parts, workmanship, or materials. The XL and XL80 disk drives seem to be just what Micro-Sci intended—a good, solid pair of 5¼-inch disk drives at modest prices.

Another new Apple-compatible drive from Micro-Sci is the Model A82—an 80 track, 328K unit with a track-to-track data-access speed of only 5 millise-

conds, much faster than the 18-millisecond access speed of a typical 35-track floppy-disk drive.

The A82 disk drive will work with either the Micro-Sci C2 disk controller card or the Apple Disk II controller card, so it can be used as a second disk drive on an Apple computer system without the need for a second controller card.

The Micro-Sci A82 drive comes with a utility software diskette containing programs that allow DOS 3.3, CP/M, and Pascal I.I programs to be stored on the A82 and to take advantage of its full storage capacity and increased track-to-track access time.

Other Apple-compatible disk drives in the Micro-Sci line include the A2, the company's original 35-track, 143K direct replacement for the Apple Disk II drive; the A3, a 143K unit designed for Apple III-series computers; the A73, an Apple III-compatible 70-track drive with 286K of storage capacity; and the A143, a 140-track, 572K Apple III-compatible drive.

Micro-Sci, Model XL \$199; Model XL80 \$299; Model A82 \$569; A2 \$299; A3 \$379; A143 \$659

MITSUBISHI DISK DRIVES

Mitsubishi makes many varieties of floppy-disk and hard-disk drives. Most Mitsubishi drives are sold in large quantities to computer manufacturers and commercial users, but single-unit sales are also possible.

One of Mitsubishi's newest models is the MF353, a 3½-inch double-sided drive that is similar to an earlier Mitsubishi unit, the single-sided MF351. The MF353 is only about one-fourth the volume of a standard 5¼-inch floppy-disk drive, and weighs only 1½ pounds. But it has a full 1-megabyte storage capacity.

The Mitsubishi MF353 is equipped with a direct-drive, high-torque, brushless DC-spindle motor that is especially designed to reduce data error caused by electrical interference. It also uses a sophisticated LSI (Large-Scale Integrated) circuit design that reduces the number of electronic components required to make the drive run. Still another feature is an advanced steel-bank head position mechanism which, according to Mitsubishi, results in a track-to-track access time of only 3 milliseconds. And the drive has a one-touch loading and ejecting mechanism that makes inserting and removing disks easy and trouble-free.

The MF353 sells for \$210 in bulk quantities—not including a disk-controller card, since it is intended to be sold to computer manufacturers, who generally design their own disk-controller hardware.

Mitsubishi also has a new 5¼-inch hard-disk drive: the MR521, a half-height unit with 13 megabytes of capacity, unformatted. The drive uses a double-sided disk with 640 tracks per side and 10,417 bytes per track, as well as a high-precision servo-controlled stepper motor with microprocessor-activated temperature compensation. It measures 5¾-inches wide by 1 2/3 inches high by 8 inches deep, and weighs 3⅓ pounds. It sells for \$650 in bulk quantities, not including disk-driver hardware or any sort of disk operating system.

There's also a new 8-inch Winchester drive from Mitsubishi: the M4870, available for \$6,000 in wholesale quantities, not including controller hardware or an operating system. The new M4870 drive offers 251.4 megabytes of storage capacity, unformatted, and extremely fast access speeds: 4 milliseconds track-to-track, and 20 milliseconds average access time. The unit also features a high-performance breathing filter and air-recirculation system to maintain a contamination-free environment for its low-flying heads.

The M4870 drive has eight platters with a total of 12 data surfaces and 12,276 total tracks. Maximum storage capacity is 20,480 bytes per track and 20.95 bytes per surface. The M4870 has a built-in DC power supply, and its dimensions allow side-by-side mounting of two units in a standard 19-inch rack. The drive measures 8½ inches wide by 10⅝-inches high by 29⅓-inches deep, and weighs 88 pounds.

Mitsubishi, MF353 \$217; MR521 \$770; M4870 \$6000

MOUNTAIN COMPUTER HARD-DISK DRIVES

Mountain Computer manufactures hard-disk drives that are compatible with a wide variety of personal computers. One of the company's newest and most popular products is the Mountain Dynamic Hard-disk System, which is available in two different series: one compatible with Apple II-series and Apple-III series computers, and one compatible with the IBM Personal Computer and the IBM PC-XT.

Mountain Computer also offers a hard-disk drive that can be installed in the cabinet of an IBM Personal Computer, in exactly the same spot where IBM places the hard-disk drive that comes with the IBM PC-XT. This system uses the IBM-XT disk controller and operating system. It sells for a suggested \$2,195, and can therefore be used to upgrade an IBM PC into an IBM-XT for about \$700 less than the cost of a factory-equipped PC-XT.

The Mountain Computer hard-disk system for

Apple II-series computers is compatible with ProDOS, the new disk operating system that Apple now uses for all of the computers in its II-series line. So the system can be used not only with the Apple II and II Plus, but also with the Apple IIe. And, because of a "dynamic" file-allocation technique, the system offers a storage capacity up to 30 percent greater than that of competitive equipment, Mountain Computer says.

"You can define the maximum volume size when creating a volume, but no disk space is actually used until the file is physically written on the disk," the company explains. "And, unlike any other system, no reformatting is necessary if you need to reallocate space." Unlike many other hard disks, Mountain Computer adds, its hard-disk system allows you to decide how much space you will need for ProDOS, DOS 3.3, and CP/M files, depending upon your own personal needs.

The Mountain Computer hard-disk system for Apple II-series computers can be networked with the Softworks *ProNet* software program, providing up to 128 work stations. The system for Apple III and III Plus computers supports Apple II emulation mode, and can therefore be used with Apple II emulation mode, and can therefore be used with Apple II software.

Mountain's hard disks for Apple computers can be used with a wide variety of software packages, such as the Great Plains accounting program, the BPI accounting package, and many CP/M programs, including *WordStar* and *MultiPlan*.

The Mountain Computer hard-disk systems for the IBM PC are designed to function exactly like IBM's own PC-XT disk drive, and to be completely hardware- and software-compatible with the IBM PC-XT, without any hardware modifications or software patching. But they run faster than the PC's factory-installed hard-disk drives, and also offer increased storage capacity.

Because of their compatibility with IBM's original equipment, Mountain's IBM-compatible hard-disk drives are compatible with all software packages that can be run on the IBM PC-XT, including *Lotus 1-2-3*, *DBase II*, *WordStar*, *SuperCalc II*, *Vision*, *PFS:File*, and many, many more.

Mountain Computer's hard-disk drive systems are well designed, quiet running, and solidly built for years of trouble-free operation. They can (and should) be used with another Mountain Computer product, the FileSafe tape backup system. The FileSafe system is available in versions designed to be used with all Mountain hard-disk drives.

Mountain Computer, Apple \$1,995–\$3,495; (10Mb)

\$2495; (15Mb) \$2995; (20Mb) \$3495; IBM \$1,995–\$4,495; (10Mb) \$2395; (15Mb) \$2795; (20Mb) \$3295; (35Mb) \$4495

PERCOM DATA DISK DRIVES

Percom Data Corporation has been building mass-storage devices since the mid-1970s and is now one of the world's leading manufacturers of disk drives for small computers. Percom now offers floppy-disk and hard-disk drives designed to be used with Apple computers, Atari computers, the IBM Personal Computer, Tandy (Radio Shack) computers, and the Texas Instruments 99/4A.

All Percom disk drives equal—and in some cases exceed—the performance specifications of drives offered as original equipment by computer manufacturers. A number of Percom's floppy-disk drives are double-density models that can store up to twice as much data as original-equipment drives.

One of Percom's newest products is the PHD, a hard-disk drive that can be used with Apple II-series computers, and the IBM-PC. The Percom PHD is available with a capacity of 5, 10, 15, or 20 megabytes. The drive has a built-in controller that can handle up to two additional drives, for a total possible storage capacity of 60Mb.

The IBM PC-compatible version of the PHD is compatible with both PC-DOS 2.2 and CP/M-86. And, with the addition of an optional circuit called a caching driver, the PHD's data-transfer rate can be significantly increased—up to more than five times the normal data-transfer speed of a hard disk, according to Percom.

Actually, a caching driver can speed up the operation of a hard-disk drive only in some applications—and can actually slow it down in others. Caching is a kind of virtual-memory system in which large disk files are read into the memory of a computer. Then they can be read from and written to while they reside in memory, and the disk from which they were taken does not have to be reaccessed until processing on the files is completed.

File-caching works fine when long, consecutive files are being accessed, but can actually slow processing down when small segments of various files are being worked on simultaneously. Thus it might be wise to question Percom's unqualified claim that a caching driver can make its PHD system five times as fast as a factory-installed IBM PC-XT hard-disk drive.

The Apple-compatible version of the Percom PHD, which can also be used with Franklin computers, is compatible with Apple DOS 3.3 and Apple CP/M cards. The TRS 80-compatible version is compatible with LDOS and DOS Plus. Percom's

10Mb PHD can be ordered with an optional driver that makes it compatible with the TRSDOS 6.0 disk operating system used in the Tandy (Radio Shack) TRS-80 Model IV.

The Percom PHD is equipped with a non-removable 5¼-inch hard disk, and has an average track-to-track access time of 3 milliseconds and a data transfer rate to 5 million bits per second. The drive comes with appropriate interface connector cables and installation manuals. Appropriate utility software is also included.

Percom's floppy-disk drives included the AT-88S1, a single-sided, single-density unit for Atari computers; the AT-88S1PD, a single-sided, double-density drive for Atari computers; and the TX-99, a single-sided, single-density model for the now-defunct TI99/4A. All of the drives in these two lines are plug-compatible with the computers for which they were designed, and can be run using their host computers' standard disk operating systems. The TX-9 can be plugged directly into a TI-99/4A, without the need for the expansion box that disk drives manufactured for that computer usually require.

The Percom AT-88S1 disk drive for Atari computers has a storage capacity, when formatted, of 88K—the same capacity as Atari's own Model 1050 disk drive. The AT88S1PD double-density drive has a formatted storage capacity of 176K. The Percom TX-99 drive for the TI-99/4A has a storage capacity of 92K, the same as the capacity of the disk drive that TI used to manufacture for its 99/4A.

Percom Data, PHD (5Mb) \$1,895; (10Mb) \$1395; (15Mb) \$2195; (20Mb) \$2795; AT-88S1PD \$419; caching driver \$150

THE QUADRAM QUADDISK

Quadram claims to offer the highest-capacity IBM PC-compatible hard-disk drive on the market—and so far, no other company has stepped forward to dispute that claim. The unit, called the QuadDisk 72, has a data-storage capacity of 72 megabytes, approximately the equivalent of 36,000 pages of text.

There are also four other disk drives in Quadram's QuadDisk line: a 6Mb fixed-disk drive, a 6Mb removable-disk drive, and a 27Mb fixed-disk drive.

Quadram's hard-disk drives are sturdily built, quiet-running units with built-in power supplies. Quadram says that the QuadDisk system has a 99.5 percent reliability factor, making it one of the most trouble-free hard-disk systems available.

QuadDisk drives run under a proprietary menu-driven operating system that does not require the use of standard IBM PC-DOS 2.2 commands, and

can thus simplify file-handling. Another feature of the QuadDisk system is a cache buffering capability that can speed up data-transfer time when long files are being accessed. Still another feature is multi-tasking capability; the QuadDisk system comes with a software package that allows up to nine tasks to run concurrently on an IBM PC equipped with a QuadDisk drive.

Quadram, QuadDisk 72 \$6,500; 6Mb fixed-disk drive \$1,995; 6Mb removable-disk drive \$2,195; 27Mb fixed-disk drive \$2,895

QUENTIN DISK DRIVES

You may not have heard of Quentin Research, Inc., of Chatsworth, California. But that doesn't mean that Quentin is a small company. Actually, it's one of the largest manufacturers of mass-storage equipment in the personal computer industry—but the company has traditionally dealt more with other companies in the industry than with the retail market. For example, Quentin manufactures the disk drives used in Data General computer systems.

Recently, in an effort to become better known in the retail marketplace, Quentin has been placing more emphasis on promoting its excellent consumer line of floppy-disk and hard-disk drives. The company's floppy-disk drives include the AP-100, a 5¼-inch disk drive designed to be used with Apple II-series and III-series computers; the AP-105, a half-height Apple-compatible 5¼-inch drive; and the AP-110, a slimline two-drive Apple compatible 5¼-inch system.

Quentin also manufactures two hard-disk drives that can be used with Apple computers and the IBM Personal Computer. One model, the Q-700, is available with 5 to 15 megabytes of storage capacity and is also equipped with a 26-megabyte tape-streamer system. The other unit, the Q-500, is also available with 5 to 15 megabytes of storage capacity but does not include a backup system.

Quentin Research, Inc., AP-100 \$295; AP-105 \$285; AP-110 \$595; Q-550 \$1,995 to \$2,795; Q-700 \$2,995 to \$3,795

RANA DISK DRIVES

Is it a disk drive? Is it a computer? Is it both? Maybe. It's the 8086/2 intelligent disk-drive from Rana Systems, which is equipped with a built-in 16-bit 8086 microprocessor and is designed to make an Apple II-series computer—including the Apple IIe and the new Apple IIc—compatible with software written for the IBM PC.

The 8086/2 disk drive is only one of many disk drives manufactured by Rana Systems. Rana is a leading manufacturer of microcomputer disk drives, and offers a wide variety of drives that can be used with computers manufactured by companies such as Apple, Atari, and IBM.

One particularly advanced drive—as advanced in its own way as the 8086/2—is the Rana 2.5 Super Floppy Disk system. The Rana 2.5 Super system, designed to be used with the IBM Personal Computer and PC lookalikes, can store an astounding 2.5 megabytes of data onto a single 5¼-inch floppy.

But back to the 8086/2 for a moment: Cosmetically as well as electronically, the Rana 8086/2 is an excellent match for the Apple IIe and the Apple IIc. The unit can be used with any disk—DOS 3.3 or ProDOS—that can be run on a standard Apple II disk drive.

Unfortunately, though, the Rana 8086/2 can't run just any IBM PC-compatible disk. It will enable Apple computers to run some PC-compatible software, but it can't make an Apple computer 100 percent PC-compatible.

That shortcoming is not the fault of the 8086/2 drive. It's because the IBM PC has certain features that Apple computers lack, such as a larger memory capacity, more keyboard functions, and a different kind of video driver. Generally speaking, programs that make use of the PC's special features cannot be run successfully on an Apple computer, while those that don't require the use of the PC's special capabilities can. For example, the IBM PC version of *Lotus 1-2-3* will run on an 8086/2 drive (with one slight modification), while programs such as Sublogic Systems' *Flight Simulator*—which is designed to be used with the IBM PC's oddball monochrome driver—will not work on the 8086/2 system.

Rana's other highly advanced new drive, the Model 2.5 Super Floppy Disk system, cannot be used with ordinary 5¼-inch floppy disks. It must be used with special preformatted, quad-density disks that have 2.5 megabytes of storage capacity—eight times the capacity of an ordinary 5¼-inch floppy.

The Rana 2.5 can be hooked up to an IBM PC quite easily, however; it can be connected directly to the standard disk controller card inside an IBM PC, and it is completely compatible with the PC's original-equipment disk drives. The price of the Rana 2.5 had not yet been set when this review was written.

Rana Systems, 8086/2 \$1,795; 2.5 Super System \$1550

SHUGART DISK DRIVES

Shugart is a 10-year-old company that manufactured 1,000 disk drives during its first year of operation and was turning out 5,000 drives a day by last year. The company now offers a broad line of disk drives for small computers, including 3½-inch microfloppy drives, standard-height and half-height 5¼-inch floppy-disk units, 8-inch floppy-disk drives, and both 5¼-inch and 8-inch hard-disk drives. The company also produces hard-disk and floppy-disk controllers, and even makes an ultra-advanced 1-gigabyte optical disk drive.

One of Shugart's newest products is the Model 350 microfloppy disk drive, a unit capable of storing 1 megabyte of data (unformatted) on a 3½-inch disk. The Shugart 350 drive occupies only one fourth of the volume of a standard 5¼-inch drive, and is therefore exceptionally well suited for use with small computer systems.

The Shugart 350 drive uses double-sided microfloppy disks formatted in 512-byte sectors. There are 80 tracks on each side of each disk, with six sectors per track, for a total of 409.6K of formatted storage capacity per side, or 819.2K per disk. The 350's track-to-track access time is rated at 6 milliseconds, and its data transfer rate is rated at 250K per second.

The Model 350 is 1.6 inches high, 4 inches wide, and 6 inches deep, and weighs 1.3 pounds. It is designed to be sold primarily to computer manufacturers, and it is priced at \$200 in bulk quantities, not including any disk-controller hardware or any disk operating system.

Shugart also manufactures another microfloppy disk drive, the Model 300, which is similar to the Model 350 but has only half of the 350's storage capacity.

There are two Shugart hard-disk drives: the Model 706S, which sells in bulk quantities for \$661, and the Model 712S, which has a wholesale price of \$716. Both models use a 5¼-inch disk and have similar specifications. But the 706S has a formatted capacity of 5 megabytes, and the 712S is a 10Mb drive.

The Shugart 706S and 712S can be connected easily and inexpensively to almost any type of microcomputer, thanks to a built-in "intelligent" interface called a Small Computer System Interface, or SCSI. Other features include a brushless DC spindle motor, four-point shock mounts, and a data transfer rate of up to one megabyte a second. The two units have the same dimensions: 2.86 inches high, by 5.75 inches wide, and 8 inches deep. And both drives have the same weight: 3.8 pounds.

Shugart, Model 300 \$205; Model 350 \$279; Model 706S \$957; Model 712S \$957

SOFT STROKE

A lot of computer users these days complain about the keyboard that comes with their new computer. Well, Apple owners, now you can design your own keyboard, or adapt the one of your choice, with the help of the Soft Stroke card from EMRI computer.

The Soft Stroke is a keyboard controller card for the Apple II. This 9-inch by 3-inch card plugs into any one of the Apple's expansion slots, and permits you to connect either the standard Apple II keyboard, or an external 7- or 8-bit ASCII encoded, parallel output keyboard. The card is designed to let the user adapt full-size keyboards for operation with the Apple II computer. It allows redefinition or repositioning of any character-code-generating key of the keyboard. Any key may be defined as a macro key and all keyboard translation parameters are stored in battery-backed CMOS RAM (2K).

Soft Stroke's on-board software includes a sophisticated keyswitch editor that allows disk storage and retrieval of keyboard definitions. Keyboard definitions may be loaded from disk using three simple BASIC commands. Soft Stroke's operating system provides 128K type-ahead buffer. The card is compatible with any operating system and there is a built-in real-time clock which has $\frac{1}{10}$ of a second resolution.

Emri Computer, \$199

SPACE COAST SYSTEMS

Space Coast Systems manufactures a series of top-quality hard-disk drives that have data-storage capacities ranging from 5 megabytes to 42 megabytes and are compatible with an extraordinarily wide range of personal computers. Space Coast drives can be used with Apple computers; the IBM Personal Computer; computers that use the S-100 bus; computers built around the Z80 microprocessor; and computers manufactured by Cromemco, Epson, NEC, NCR, Osborne, Victor, Xerox. The drive designed for use with Apple computers is completely compatible with ProDOS, the new disk operating system that Apple is now using for its II-series computers.

The basic hard-disk drive manufactured by Space Coast, called the ICE Microcube Mass Storage System, is available in 5Mb, 10Mb, 21Mb, and 42Mb versions. The drives can be daisy-chained into any configuration desired, all the way up to a total storage capacity of 84 megabytes.

The Microcube drive is a compact, quiet-running drive that measures just $7\frac{1}{4}$ inches high, $6\frac{3}{4}$ inches wide, and $11\frac{3}{4}$ inches deep. Until recently, all models were equipped with a $5\frac{1}{4}$ -inch hard disk. But now the 5Mb and 10Mb are also available in an alternate version that uses a $3\frac{1}{2}$ -inch disk and sells for the same price as the $5\frac{1}{4}$ -inch model.

In all its configurations, the Microcube drive has a data transfer rate of 5 million bits per second and a track-to-track access time of 18 milliseconds, including settling time.

Each ICE Microcube hard-disk system comes with an adapter that can interface it quickly and easily with any compatible computer. Other items supplied with the system include a drive controller, a power supply, all necessary cables and connectors, all necessary software, and an installation manual.

Other products manufactured by Space Coast Systems include a high-speed tape backup system for hard-disk drives called the ICE Datavault; a lower-speed Datavault backup system that uses floppy disks instead of tape cartridges; and the ICE Star System, a multiplexing system that can be used to connect up to eight microcomputers to a ICE hard-disk drive.

Space Coast Systems, ICE 5mb \$1,995; 10mb \$2,595; 21mb \$3,995; 42mb \$5,695; Datavault for hard disk \$2495

TALLGRASS TECHNOLOGIES

Tallgrass Technologies offers a line of IBM PC-compatible hard-disk drive systems ranging in capacity from 6 megabytes to 140 megabytes. Their prices aren't small, but neither is the storage capacity of a Tallgrass drive!

The hard-disk systems manufactured by Tallgrass have been praised by critics for their speed, their capacity, and their reliability. Every Tallgrass system has a built-in tape cartridge backup system, just in case disaster strikes and all of the information on a multi-megabyte hard disk is lost. Tallgrass tape backup systems are also available separately.

Tallgrass' hard-disk systems are compatible with the IBM Personal Computer. With the addition of optional interface kits, they can also be made compatible with the IBM PC-XT, the Columbia Data Computer, and the Texas Instruments Professional Computer.

One of the most unusual features in Tallgrass' hard-disk systems is an unconventional type of disk/tape controller that controls both the hard-disk drive and its integrated backup tape drive.

This system eliminates the need for a separate disk controller and tape formatter, and makes the creation of backup tapes quick and easy.

Another unusual feature of Tallgrass drives is the way they read and write data. Tallgrass does not divide its disks into sectors, as most manufacturers in the data-storage industry do. Instead of using conventional 512-byte sectors, Tallgrass drives read and write in continuous 10K tracks. This technique increases the storage capacity of the disks used in Tallgrass drives, since it eliminates most of the unused gaps that would otherwise occur between sectors. And, contrary to what one might assume, the use of such long tracks does not appreciably slow down the operation of the drive—in fact Tallgrass drives actually run faster than many of their competitors, and operate considerably faster than the factory-installed hard-disk drive used in the IBM PC-XT.

For its hard-disk backup systems, Tallgrass uses an ANSI-standard quarter-inch certified tape, rather than floppy disks, videocassettes, or irremovable hard-disk packs. The tape comes in a cartridge, called a PC/T-11 cartridge, that Tallgrass developed specifically for hard-disk tape backup systems. The PC/T-11 format is also used by Archive and Wangtek, and Tallgrass hopes that it will eventually be adapted as a tape backup standard by others in the data-storage industry.

The PC/T-11 tape system uses individual track directories for ease of data manipulation. With these directories, the system can either copy a complete disk image onto a backup tape or back up only individual files that have been changed since the last backup was made.

Tallgrass drives are also equipped with several other features designed to protect the data stored on their disks. For example, Tallgrass disks have a special "landing zone" over which the heads float when they are not being used. So when the power to a Tallgrass drive suddenly goes off, or when the drive is accidentally bumped or jostled, the heads can't scrape across the surface of the disk, scratching it or ruining data.

Another failsafe feature of Tallgrass drives is a "read-after-write" capability that can be selected by the user when desired. When this feature is activated, data written to the disk is verified to make sure that it is accurate. Read-after-write takes extra time, but may be worth it when critical data is being saved.

The user of a Tallgrass drive can also select another option called a dual directory. When this feature is used, two identical disk directories are written on the hard disk, in two separate areas.

Then, if the primary directory is ever lost or damaged, the second directory can be used.

Tallgrass Technologies, TG-3006 (mb) \$2,995; TG-3012 (12Mb) \$3,495; TG-3020 (20Mb) \$3,995; TG-3135 (35Mb) \$5,595; TG-3170 (70Mb) \$7,495; TG-5070 (70Mb) \$7,995; TG-5140 (140Mb) \$9,495

TANDON DISK DRIVES

Tandon Corporation is one of the biggest and most successful companies in the disk-drive business, but most Tandon drives are sold OEM (Original Equipment Manufacturer) to customers, such as computer manufacturers and resellers of disk drives. So, even though there are millions of Tandon disk drives out there, you'll rarely see one bearing the Tandon name.

There are many varieties of Tandon drives, including 5¼-inch and 8-inch floppy-disk models, 3½-inch microfloppy units, and 5¼-inch hard-disk drives.

Tandon's current line of 5¼-inch floppy-disk drives include the TM50, the TM50M, and the TM55, which are all half-height units and are all available in either single-sided or double-sided versions; and the TM100, the TM101, and the TM102, which are all standard-height drives. The storage capacities of Tandon's 5¼-inch drives range from 250K for a single-sided TM50, TM50M, or TM100 to 2 megabytes (unformatted) for the double-sided, double-density Model TM102 drive.

Tandon's best-selling 8-inch floppy-disk drive is the TM848E, a slimline unit which is available in both an 800K single-sided version and a 1.6-megabyte double-sided version. The company currently offers one 3½-inch floppy-disk drive—the microprocessor-controlled TM35—but it is available in two single-sided and two double-sided versions, with storage capacities ranging from 500K to 1 megabyte.

There are three series of Tandon hard-disk drives: the TM250, the TM500, and the TM700. The TM250 is available in both a one-platter version and a two-platter version. The TM700 is a one-platter drive, but it is available with two different recording densities. The TM500 is available with one, two, or three platters. The storage capacities of Tandon's hard-disk drives range from 6.4 megabytes for the one-platter TM250 and the one-platter TM500 drive to 50.1 megabytes for the double-density TM700 drive.

Tandon does not set suggested retail prices for its disk drives, but they are priced very competitively with similar disk drives.

Tandon, TM50, TM50M, TM55, TM100, TM101, TM102, TM848E, TM35, TM250, TM500, TM700; prices set by dealer

12 INTERFACE DISK DRIVES

12 Interface has a broad line of very affordable hard-disk drives that are compatible with the IBM Personal Computer. In addition, Interface manufactures moderately priced floppy-disk drives that are designed to be used with the IBM PC and also with personal computers manufactured by Apple, Radio Shack, and other companies.

One of Interface's most popular products is the 12B-10P DiskSystem, an IBM PC-compatible hard-disk drive. There are also three other hard-disk drives in the 12 DiskSystem line: the 15K 12BM-15P, the 25K 12BM-25P, and the 33K 12BM-33P.

Each drive in the 12 DiskSystem series has a track-to-track data-access time of 2 milliseconds. Average access time is 85 milliseconds for the 12BM-10P and the 12BM-15P, and 54 milliseconds for the 12BM-25P and the 12BM-33P.

Each drive in the DiskSystem series comes with a disk controller, all necessary cables and connectors, an I/O adapter, and a device driver—in other words, everything that's needed to get the system up and running with an IBM PC.

Interface also offers a line of DiskSystems hard-disk drives that are designed to be connected to the IBM PC-XT computer, either to back up the computer's built-in hard-disk drive or to provide additional formatted hard-disk storage capacity. The PC-XT add-on units offered by 12 Interface range from 10Mb to 33Mb in storage capacity, and in price from \$1,195 to \$2,295.

12 Interface also offers a number of single-density and double-density 5¼-inch and 8-inch floppy-disk drives. The company's 5¼-inch floppies are available in both full-height and half-height models

and in both single-drive and dual-drive configurations that are compatible with computers made by Apple, Radio Shack, and other companies. The suggested retail prices of 12 Interface floppy disk drives range from \$185 to \$575, depending upon the model selected.

12 Interface is at 7630 Alabama Avenue, Canoga Park, CA, 91304.

12 Interface, 12BM-10P \$1,495; 12BM-25P \$1,795; 12BM-25P \$2,245; 12BM-33P \$2,795; PC-XT hard-disk drives, (10Mb) \$1195; (15Mb) \$1295; (21Mb) \$1895; (33Mb) \$2295; floppy-disk drives, TM-100-2 \$325; dual \$550

VISTA SOLO AND SOLO PLUS

The Vista Solo is an add-on floppy disk drive that is completely compatible with the Apple II computer and the Apple disk controller card. The Solo Plus includes the Vista disk controller card as well as the drive, but it does not include DOS 3.3.

Vista buys the mechanical part of these drives from the same source as Apple but adds its own electronics. The Solo drive works just like the Apple II disk drive and is just as noisy, but because it is cheaper than the Apple drive and performs adequately, it provides a viable route for upgrading your system.

The controller that is sold with the Solo Plus works well, but it is twice the size of the Apple controller and has a mechanically awkward connector for the disk drive cable. The orientation of the connector makes it difficult to place another board next to the controller card.

The Solo is an inexpensive clone of an old Apple design.

Vista Computer, Solo Plus \$379; Solo \$299

SOFT DISK DRIVES

Manufacturer	Model	Sides/ Disk	Density	Disk Size (inches)	Capacity (Kbytes/ Megabytes)	Compatibility *	Price
Amdtek	Amdisk-V	1	Single	5.25	250K	Various	\$658
	Amdisk-V	1	Double	5.25	500K	Various	N/A
	Amdisk-I	1		3	2x143K	Apple II	\$299
	Amdisk-III	1	Single	3	624K	TI-99/4A	\$599
	AMDC-1	1	Single	3	180K	Atari	\$599
	AMDC-2	1	Single	3	360K	Atari	\$850
Apple	Disk II	1	Single	5.25	140K	Apple II	\$395
	DuoDisk	1		5.25	280K	Apple II	\$795
Atari	1050	1	Single	5.25	133K	Atari	\$449
Comrex	CR-1000	1	Single	5.25	286K	Apple IIe	\$599
Control Data	9400 Series	Various	Various	5.25	125K-1M	Universal	\$150-380
Indus	GT	1	Double	5.25	90-180K	Various	\$300-500
Interface	12A	Various	Various	5.25	Various	Apple II	\$185-575
Micro-Sci	XL	1	Single	5.25	164K	Apple II	\$199
	XL80	1	Double	5.25	328K	Apple II	\$299
	A2	1	Single	5.25	143K	Apple II	\$345
	A3	1	Single	5.25	143K	Apple III	\$379
	A73	1	Double	5.25	286K	Apple III	\$529
	A82	1	Double	5.25	328K	Apple II	\$569
	A143	1	Double	5.25	572K	Apple III	\$659
Mitsubishi	MF353	2	Double	3.5	1M	Universal	\$210 ‡
Percom	AT-88S1PD	1	Single	5.25	176K	Atari	\$419
Quentin	AP-105	1	Single	5.25	140K	Apple II	\$285
	AP-100	1	Single	5.25	140K	Apple II	\$295
	AP-110	1	Single	5.25	280K	Apple II	\$595
Rana	Elite I	1	Single	5.25	164K	Apple II	\$349
	1000	1	Double	5.25	184K	Atari	\$449
	Elite II	2	Single	5.25	328K	Apple II	\$549
	Elite III	2	Double	5.25	6.5M	Apple II	\$649

SOFT DISK DRIVES (Continued)

Manufacturer	Model	Sides/ Disk	Density	Disk Size (inches)	Capacity (Kbytes/ Megabytes)	Compatibility*	Price
	8086/2	1	Single	5.25		Apple IIe	\$1,795
Shugart	300	2	Single	3.5	410K	Universal	\$205
	350	2	Double	3.5	819K	Universal	\$200‡
Tandon	TM50-1	1	Single	5.25	250K	Universal	\$200
	TM50-2	1	Single	5.25	500K	Universal	\$250
	TM55-2	1	Double	5.25	512K	Universal	\$310
	TM55-4	2	Double	5.25	1M	Universal	\$360
	TM-100-1	1	Single	5.25	250K	Universal	\$250
	TM-100-2	2	Single	5.25	500K	Universal	\$340
	TM-100-3/3M	1	Single	5.25	500K	Universal	\$340
	TM-100-4/4M	1	Single	5.25	1000K	Universal	\$450
Trak	A2D2	1	Double	5.25	184K	Atari	\$499
Vista	Solo	1	Single	5.25	143K	Apple II	\$299

* Apple II: Apple II series; Columbia: Columbia Data Systems; TI Professional: Texas Instruments Professional; TI 99/4A: Texas Instru-

ments 99/4A; Universal: for drives sold without driver hardware. ‡ Wholesale price; retail price not available.

HARD DISK DRIVES

Manufacturer	Model	Sides/ Disk	Disk Size (inches)	Capacity (megabytes)	Compatibility*	Price
Apple	ProFile	2	5.25	5	Apple II & III	\$2200
Comrex	Comfiler	2	5.25	10	Epson QX-10	\$2295
Control Data	Wren	Various	5.25	21.8–85	Universal	\$1875
	Lark	Various	8	16.7–50	Universal	\$2250
	FSD Series	Various	9	166–516	Universal	N/A
Corona	Starfire	1	5.25	5	Various	\$2995
Corvus	OmniDrive	Various	5.25	5–45	Various	\$1995–4995
Davong	100 Series	Various	5.25	5–32	IBM PC	\$1845–3995
	A20 Series	Various	5.25	5–15	Apple II	\$1995–2795
	Hard Disk	1	5.25	5–32	IBM PC, Apple II, Osborne 1	\$1995–3995

HARD DISK DRIVES *(Continued)*

Manufacturer	Model	Sides/ Disk	Disk Size (inches)	Capacity (megabytes)	Compatibility *	Price
Genie	5F	2	5.25	5	Various	\$2295
	10F	4	5.25	10	Various	\$2595
	15F	6	5.25	15	Various	\$2895
	20F	8	5.25	20	Various	\$3195
	X5A	1	5.25	5	Various	\$3295
	5 + 5	2	5.25	10	Various	\$3995
Interface	12BM	Various	5.25	10-33	IBM PC	\$1495-2795
Maynard	WS 1	1	5.25	10.6	IBM PC	\$1395
	WS 2	1	5.25	10.6	IBM PC	\$1595
	WS 3	1	5.25	10.6	IBM PC	\$1595
Mitsubishi	M4870	12	8	251.4	Universal	\$6000†
	MR 521	2	5.25	13	Universal	\$650†
Mountain	Dynamic	1	5.25	5-20	IBM PC, Apple II	\$1995-4495
Percom	PHD	Various	5.25	5-20	Apple II, IBM PC	\$1895
Quadram	QuadDisk	Various	5.25	7-72	IBM PC	\$1995-6500
Quentin	Q-500	Various	5.25	5-15	Various	\$1995-2795
	Q-700	Various	5.25	5-15 +	Apple II, IBM PC	\$2995-3795
Rana	2.5	1	5.25	2.5	IBM PC	\$1550
Shugart	706S	1	5.25	5	Universal	\$661†
	712S	2	5.25	10	Universal	\$716†
Space Coast	Microcube	Various	5.25	5-42	Various	\$1995-5695
Tallgrass	TG-3006	2	5.25	6.3	IBM PC, Columbia, TI Professional	\$2995
	TG-3012	4	5.25	12.5	IBM PC, Columbia, TI Professional	\$2995
	TG-3020	4	5.25	19.7	IBM PC, Columbia, TI Professional	\$3995
	TG-3135	5	5.25	35.7	IBM PC, Columbia, TI Professional	\$5595
	TG-3170	7	5.25	70.7	IBM PC, Columbia, TI Professional	\$7495

* Apple II: Apple II series; Columbia: Columbia Data Systems; TI Professional: Texas Instruments Professional; TI 99/4A: Texas Instru-

ments 99/4A; Universal: for drives sold without driver hardware.
† Wholesale prices; retail prices not available.

BOARDS & MISCELLANEOUS ADD-ONS

INTRODUCTION

Expansionism is a political term referring to a country's desire to expand beyond its own borders. The concept of Expansionism also has validity in the computer field. Seldom does a person buy a computer and then leave it the way it was. A daily lament of computer owners is, "If I only had a . . . , then my computer would be complete." Of course, once the purchase is made, something new is always found to add to the person's wish list.

Additional computer-related purchases range from software to circuit boards, from cases to covers, and from books to diskettes. There is a never-ending stream of products from a limitless number of suppliers crowding the pages of your favorite magazine.

The most important purchases seem to be those that add power to the box on your desk, namely software and add-on boards. Not only are these products the most expensive items in most cases, but they also take the most research on the part of the user to insure that they will do the job intended. Throughout the following section of the *Omni Directory*, we will do our best to enlighten you about the features and pitfalls of buying add-on boards to increase your computer's power.

OF BOARDS AND BUSES

The ability to expand a computer is the result of the way it was designed. Most computer manufacturers assume that the user would like to add new features in the future. Because of this, the "open system" design method is quite common. This does not mean, however, that all add-on boards will fit all computers. On the contrary, in order to be able to add boards to your system, you may have to know which of the many types of architecture your computer uses.

Microcomputer history takes us back to January of 1975, the date the Altair microcomputer was introduced. In addition to being the first microcomputer, the Altair introduced the S-100 bus. Although MITS, the company that produced the Altair, is no longer in business, it was their S-100 bus design that opened up the world of microcomputing. The S-100 became the de facto standard very quickly, and is still used in a large number of machines today.

A bus is a system that enables the various parts of the computer to talk to one another. It takes the form of a "data highway" on which a circuit board

can put information or gather information. It enables a manufacturer to build a board for any computer that has a bus, knowing that the board will work if it is designed to the standards for that bus. Because many microcomputer companies in the late 1970s adhered to the S-100 standard, it allowed small manufacturers to build their add-on boards with the confidence that there would be a market for them.

Today, we don't talk about the bus, we talk about the number of open "slots" in the computer. The slots are, in actuality, the openings to the bus. When a purchaser finds that the IBM PC has five slots, he or she then knows how many features can be added to the basic computer. In order to upgrade a computer system, a user must know which boards will work with that computer's bus. Because most manufacturers target their advertising to computer magazines that serve a particular machine, and because dealers are usually knowledgeable about such details today's computer user does not need a technical background. But in order to be a wise consumer, it doesn't hurt to understand some of the inner workings of the system.

The major micro computer buses used over the past 10 years are the S-100 (also known as I E E N-6), Hewlett Packard's GENERAL PURPOSE INSTRUMENT BUS (also known as GPIB), Commodore's I E E E 488 (a version of the GPID), SMOKE SIGNAL BROADCASTING'S ss-50, Radio Shack's TRS-80 bus, Apple's Apple II bus, plus the current market leader, the bus of the IBM PC. There are other bus configurations, but the preceding list covers over 95 percent of all micros ever built.

TYPES OF BOARDS

Any printed circuit board other than the "motherboard" or "system board" can be considered an add-on board. Because new ideas are forthcoming every day, the following list is not complete, but it should cover most of the add-ons that the average buyer will be looking for in the near future.

Most computers do not have a builtin ability to talk to the outside world. They must have one or more circuit boards added to them in order to be able to "hear" what the keyboard is saying, to send information to the computer's screen or printer, and to connect to the telephone system for outside communications. These boards are available in many varieties, some with a single purpose and others that perform several functions.

A terminal board allows a computer to listen to the keyboard of the terminal and to send characters back to the terminal's screen. A display board, on the other hand, usually communicates with just a screen, or monitor. Some display boards handle simple text, while others allow quite complex graphics control.

The circuit boards that drive many types of communicating devices are called "ports." There are two varieties of ports that the computer user will find most useful, the serial port and the parallel port. A serial port sends its signals out to a terminal, a printer or an external modem in a "serial" fashion, that is, one bit of data at a time. The parallel port is a faster method of communicating, sending data out many bits at a time. A serial port is normally called RS-232 compatible, while a common parallel port is the "Centronics" port, designed to drive many of today's printers.

To use both an external modem and a printer requires two ports, unless the user wants to be bothered with switching cables back and forth. Today, the best way to avoid cable-switching is by buying a multifunction board. For a reasonable cost, these boards provide one or more of each type of port, allowing a variety of communication options.

Stand-alone internal modems are a popular new option, and usually have their own builtin serial port. They come in various speeds, and are controlled from the keyboard by available software. Separate printer boards are also available, but are not particularly popular because they cost more than adding a parallel port to a multifunction board.

Since the introduction of the floppy disk drive, one major category of add-on has been the disk controller board. Today, this category can be divided into several subcategories, depending on the types of disk drives supported. The most common board, one that many purchasers are not even aware of, is the floppy disk controller. It comes packaged into many machines in their standard configuration and will usually handle from 2 to 4 floppy disk drives of the 5¼ inch variety.

Some newer machines now come with a fixed disk controller card, which will control from 1 to 4 Winchester-type disk drives. Other cards have the ability to talk to other sizes of disk drives, including the 8-inch drive, or a combination of drive sizes. Most often, you will buy the disk controller card

made by the manufacturer of your computer. An exception to this, the complete fixed disk drive systems, are quite popular as stand-alone purchases.

Memory boards comprise a very popular add-on to many computers today. These boards come in a variety of sizes, and often include other functions as well. When considering the purchase of a memory board, you should be aware of the maximum memory that can be addressed by your computer, and the amount now installed. The difference between these two numbers is the amount of memory that you will invariably want, at least sometime in the future. Don't buy a board that will not take your system up to maximum memory through the addition of more memory chips. To do so will only cost you more money in the long run. Most manufacturers know this, and have memory boards that are designed to fill the gap, and that allow the addition of memory in increments, usually 64K at a time.

One popular type of memory board is known as the "ram disk" or "electronic disk" board. This is a board that contains a large amount of memory designed to act like a diskette drive. The advantage is the their speed, which is many times faster than a disk drive. Most of these boards can also provide print spooling, the ability to send information to the printer while the user does other things with the computer. Many of today's memory boards now include software to allow their use as a ram disk when memory is not in use for programs and data.

Clock/calendar functions can be purchased separately, and are a useful addition to any computer. Most often, however, they should be purchased in conjunction with other functions, as the cost is lower due to the economies of the manufacturer when only one printed circuit board must be designed and produced.

Game adapters, or game ports, are for people who are serious about their game-playing. As usual, these boards can be purchased separately, but are quite often available as an option on a multifunction board, keeping the cost down. When purchasing the game port, be sure that it will work with your favorite game paddle or joystick.

The add-on boards described above include only the most frequently used boards. In addition to these, there are hundreds of special-purpose boards. Coprocessor boards give your computer the ability to use another microprocessor's programs, such as running Z-80 programs on the IBM PC. Networking boards allow several computers to

be tied together into a shared network. Speech boards let you talk to your computer, and let it talk back to you. Devices such as a video tape recorder, a mouse and a BSR X10 home control system can be hooked up to your computer through available add-on boards. Finally, many scientific and commercial functions can be added to the microcomputer through boards designed for process control, mainframe computer interface, circuit board design and ROM programming and control.

SUMMARY

With all of the available options, choosing the right upgrade strategy can be difficult. The best way to accomplish this is usually to list your "ideal" system in terms of functions to be performed. If you will someday want high-resolution graphics, put this on the list. In the same fashion, list each of the things that will make up your ultimate computer.

When the list is completed, search through the following pages and try to find boards that are compatible with your computer. Then look carefully at those boards that perform more than one function. Compare prices of single function boards with multifunction boards. What would be cheaper in the long run? The multifunction board will cost \$700, more than you intended to spend. But if, over the next 15 months, you would put out \$1,000 for the same functions on single boards, you will have spent \$300 more, and probably used up all of your system's slots. At this point, an expansion board might be necessary, costing another \$400 to \$1,000. Careful planning is obviously the key here. Spend plenty of time now, and you will reap the rewards in the future.

ACCELERATOR II

Want more speed from your Apple II or II+? Get the Accelerator II card from Titan Technologies. With this card, your Apple will run three times faster than normal.

The Accelerator II is a parallel processor board that has its own 6502 microprocessor and 64K of RAM. Once the board is installed, your Apple microprocessor will handle only the video display; the Accelerator II will control all other routines. Operating speed is tripled.

The documentation supplied by Titan Technologies is clear and concise. The board is easy to install—you can have the system up and running in less than an hour. Titan Technologies claims that the Accelerator II will run virtually all programs written for the Apple II or II+. Over a dozen busi-

ness software packages and six games were tested for this review, and all of them worked. If you would like to run the Accelerator II at normal Apple II or II+ speeds, you can do so, but there is no advantage in this.

Accelerator II will upgrade your Apple and give it a breath of new life. The \$599 price tag is much less than the cost of a new, more powerful computer and Accelerator II allows you to continue to use the Apple software you already own.

Titan Technologies, \$599

AD 8088 PROCESSOR CARD

The heart of the Apple II computer is a 6502 processor chip which executes programs, performs calculations, and controls every aspect of the system. The 6502 is an 8-bit processor. When it was introduced in 1975, it was considered to have an advanced design. New technology has since moved forward to the 16-bit 8088 processor chip, which features many powerful instructions not available on the 6502. The 8088 Processor Card from ALF Products offers this power to any Apple II system with 64K *Applesoft BASIC* and at least one Apple Disk II or equivalent drive.

The Processor Card allows an 8088 chip and the Apple's 6502 to run simultaneously. This means that the 6502 can handle input and output while the 8088 handles program execution. This more than doubles the processing capability of the system. The 8088 can use all peripheral cards in the Apple's expansion slots as well as the Apple's text and graphics screens. Having access to all Apple memory, the 8088 can run programs up to 128K long without requiring added memory.

The Processor Card comes with an owner's manual and a software disk. Thorough instructions make it easy to install in any Apple II bus slot.

ALF Products, Inc., \$345

ADA 1800 PRINTER ADAPTER

The ADA 1800 Printer Adapter is a simple-to-use interface designed to allow Commodore PET and CBM computers to use parallel interface printers. Manufactured by Connecticut MicroComputers, it is built to support 8 bits. The ADA 1800 works with Commodore disk drives and operates using BASIC commands.

Included in the ADA 1800 package are a two-foot cable that plugs into the Commodore PET or CBM's IEEE port. Another IEEE card-edge connector is provided for connecting floppy-disk drives

and other peripherals to the computers. Also included is a four-foot cable with a standard 36-pin Centronics connector. A simple switch selects upper/lower case, upper/lower case reversed (this is needed for some Commodore machines), and upper case only for clearer program listings and graphics.

In tests, the ADA 1800 printer adapter worked well with WordPro, BASIC, and many other programs. No special programming is required for this little box to do its job. To list a program on your computer you would just type three simple commands.

The documentation, unfortunately, is poor. Fortunately for the user, this is another simple device that doesn't require much to install and get working. The documentation aside, this is a good product that makes things a lot easier for Commodore PET and CBM users.

Connecticut MicroComputer Inc., \$129

THE ALIEN VOICE (VOICEBOX)

Speech synthesizers were costly and not very useful toys when they first appeared for use with personal computers a few years back. Today, the Voicebox costs a fraction of those early devices (about \$100) but only you can decide if it is any more useful.

The Voicebox is tiny. Its plastic case is slightly larger than a pack of cigarettes, and an edge connector attaches it to the computer. The Alien Group, which builds and sells this product, also makes fuzz-tone and other creative distortion boxes for electric guitars.

Inside the box is a speech synthesizer chip made by Votrax. This chip is at the heart of most speech boxes, including Votrax's own Type and Talk. Also inside the box are a small but adequate speaker and an amplifier. Two large knobs on top of the box control the rate of speech, the pitch of the electronic voice and the speaker volume.

The success of any speech synthesizer relies on its software, mainly on a kind of program commonly known as "text-to-speech algorithm." This type of program takes ordinary words and breaks them down into the essential parts of human speech (phonemes), then addresses the speech chip in its own special code. Several such programs come with the Voicebox; they range in quality from good to just adequate.

By experimenting with phonetic spelling, you can improve these programs' understandability. A word like "please" doesn't sound right when

spelled correctly. "Pleezz," however, sounds just fine. Also, when you want to make a plural, some "s's" are best replaced by "z's." Words with soft "e" sounds (like "get") sound better when spelled "eh." The Votrax chip also seems to have problems with "g" sounds in general, although "j" can be substituted for soft "g."

If this seems complicated, it's not. You soon adjust to the way that the talking chip works and these new spellings become second nature. It is also a simple matter to use these core programs (they're written in machine language) with your own BASIC program. Use of the box is very straightforward, and you can actually begin to write your own talking programs without even looking at the brief but otherwise good instruction book. This book explains the synthesizer chip in a little more detail and lists the special phoneme codes and alternate phonetic spellings to use instead of English text.

Alien Group: Voicebox II (Atari), \$69; Voicebox III (Apple), \$129; Voicebox (C64), \$129; Software for Voicebox: *Music Synthesis*, \$29.95; *Dictionary Editor*, \$25

ALL CARD

ALL Card is a combination board for multitasking and multiuser operating systems. Manufactured by Computers ALL, it has a variety of hardware and software options. The board can be added to an IBM PC system with only 64K of RAM, but more memory will allow you to take full advantage of All Card's features. The ALL Card works with CP/M-86, Concurrent CP/M-86, and MS-DOS. A UNIX-like operating system is planned for it as well. The board reduces overhead by using high-speed circuitry.

The ALL Card comes with Concurrent CP/M-86 and features what its manufacturer calls FMPM (fast disk, multiuser/multitask, protection, management). The protection feature creates impenetrable memory partitions for each user or task in a multitasking or multiuser situation. The management feature maps all memory into 2K units that allow efficient management of memory and I/O functions. The fast disk feature is a disk emulator.

Sixty-four K to 256K of memory can be added to the board. As soon as 256K chips become available, it will be possible to increase the board's memory to up to one megabyte.

An optional ALL Card D A Disk Controller card piggybacks onto the ALL Card. The user can also attach any combination of these four optional de-

voices: floppy disk drive, hard disk drive, hard disk cartridge, and multiple floppy cartridge drive.

This board is not for the novice. Its documentation is extremely technical and the board's functions are not needed by most individual personal computer users.

Computers ALL, Inc., \$395 to \$1,565

ALPHASYNTAURI COMPUTER MUSIC SYSTEM

The alphaSyntauri digital musical synthesizer is the centerpiece of an easy-to-use musical system that lets you play, learn, record, and listen to music, as well as create your own sounds. It comprises a five-octave velocity-sensitive keyboard with sustain and portamento pedals and interface, two 16-oscillator Mountain Computer synthesizer boards, and software for the Apple II series computers.

Three main software programs are provided: *Simply Music*, for playing, listening, and learning; *alpha Plus*, for sound creation; and *Metatrack*, for multitrack recording. Optional software includes *MusicMaster*, a teaching tool; *Composer's Assistant*, a music transcriber; *Dolphin Dialogue* (just what it sounds like); and *Musicland Games*.

The four-disk *Simply Music* program is run from five menus: Instruments, for selecting instruments; Play/Record, for making simple sound-on-sound recordings; Orchestration, for changing instrumentation in recordings; Display, for on-screen viewing of live or recorded music on a staff, a piano-keyboard representation, or a Close Encounters-type display; and Songlist, for selecting songs or groups of songs. These menus also provide for split keyboard, transposition, tempo change, metronome (not very audible), and looping of recorded tracks (not too effective). The recording feature is balky, but the rest of *Simply Music* is easy to use and well-documented.

The *alpha Plus* software comes with three diskettes and a complex manual. It includes Quick-wave, which lets you add various harmonics to create the sound you want, and Wavemaker, which allows you to draw the waves with game paddles. *Alpha Plus* also has preset waveforms, including square, sine, sawtooth, and other variations on the pulse wave. Once you've created the waveform, you set up the envelope (attack, decay, sustain and release). Also included is a wave analyzer.

Though building precise waveforms is easy enough, *alpha Plus* does not perform as well as could be expected. It has just an eight-voice polyphonic limit, it boots slowly, and the velocity-sensitive keyboard, which lets you vary dynamics

depending on how hard and fast you play the keys, does not perform as billed. There are preset sounds on disk, however, and the sounds you create can be saved for the *Metatrack* and *Simply Music* modules.

If you have ever wanted your own 16-track recording studio, *Metatrack* is for you: It provides a full 16 tracks of digital recording. Though you can't play 16 notes simultaneously, you can record 16 different tracks for orchestration, and synchronize each track of a 16-track recording—one track at a time—when sending output to a tape recorder or drum machine.

Metatrack is also alphaSyntauri's best live performance software: It lets you instantly change preset sounds from groupings of ten, split the keyboard into eight different sounds, hook up as many as eight instrumental sounds to a single key, bend pitches using game paddles, and link up to ten sounds to one key for a sequence of constantly changing tones. *Metatrack's* single disk comes with a clear manual and a quick reference guide. It boots slowly, however, has just a ten-instrument limit per preset group (you must reload other groups), and has a faint metronome track.

Overall, the alphaSyntauri combines fine hardware with some excellent and imaginative software. The system is suitable for novices or professionals, and it allows for future software enhancements. Slow booting and constant disk swapping are annoying, but musicians will appreciate the 16-track recording and the variety of sounds the system puts at your fingertips.

Syntauri Corp., Mountain Boards; Five-octave keyboard; Complete software package; prices not available

ALS CP/M CARD

There are thousands of software programs on the market today that have been written in CP/M. The ALS CP/M Card opens a whole new world to Apple II, II+, and Ile users. Advanced Logic Systems (the manufacturer) has produced a second generation CP/M Card that runs the newer CP/M Plus and runs it faster. At the heart of the board is a Z80 microprocessor that runs at a full 6 MHz. The board also includes 64K bytes of RAM and a real-time clock interrupt.

With the ALS Card you actually get a copy of CP/M Plus and Digital Research's *CP/M Plus Operating Systems Users Guide* and the Digital Research CBASIC reference guide. ALS also provides the CBASIC compiler but does not include interpreted BASIC. The board uses the Z80 microprocessor

and RAM to keep track of the date and time. The real-time clock interrupt merely generates a periodic timing signal. Since the Z80 counts the time and stores it in RAM, you must reset it each time you turn the Apple on.

The ALS Card's weak point is its documentation. There is a lot of needed information that is simply left out, and much more that is difficult to find.

Advanced Logic Systems, \$399

AMIGA JOYBOARD

Remember those indoor skiing simulators that were at all the ski resorts in the 1960s, but that never quite caught on? Well, Amiga has designed a similar device that works with an Atari VCS (or similar system). It even comes with a skiing game, *Mogul Maniac!* The Joyboard looks something like a bathroom scale, but the whole thing (including you) is balanced on a central disk that rests on the floor. It is not difficult staying balanced, although the tendency is to lean more to one side or the other, thus activating the contacts in that direction. But that is what the Joyboard is all about. Rocking the Joyboard activates the contacts in the direction you lean. The Joyboard has eight-directional capability; because of this, it is sometimes difficult to activate just one side direction alone.

While Amiga claims that "the Joyboard works with almost all Atari-compatible video games," that doesn't mean that the games are truly playable with the Joyboard. It is fun to try other games just for laughs, but you will want to play mainly the four Amiga games designed specifically for use with the Joyboard. These games include *Mogul Mania*, a skiing game with nine downhill courses; *Surf's Up*, a surfing game; *S.A.C. Alert*, a fighter pilot flying game; and *Off Your Rocker*, a bop-the-mole type of game with colors instead of moles.

Obviously, this is a specialized game controller and not a replacement for a regular joystick. It is good fun, particularly at a party, and may be the next addition for your game room.

Amiga, price not available

AMPS-II

Advanced Systems Concepts advertises their AMPS-II device as the poor man's network. Well, it's not really a network at all, but a simple switching device. From the outside, the AMPS-II looks deceptively sophisticated. Its front panel sports five switches and four LEDs, while its back panel offers five RS-232 ports, a power cord, and DIP and

thumbwheel switches. The stand-alone unit is capable of connecting as many as four computers (through their RS-232 serial ports) to a single printer or other serial output device. The AMPS-II switch requires no extra cables or computer cards.

The AMPS-II supports three operating modes: manual, automatic-timeout, and software-control. In manual, the user connects a computer to the output device simply by flipping the appropriate switch on the front panel. In automatic-timeout mode, any connected computer can seize the output line just by transmitting data, simultaneously locking out the other computers until the transmission is completed. Under software-control, a code from the computer's keyboard locks it to the peripheral for data transmission and unlocks it when the transmission is over.

The AMPS-II switch is not a local area network. It doesn't permit complex interconnections among devices. It doesn't allow waiting computers to queue. It doesn't signal waiting users when the output line becomes free. On the other hand, it is inexpensive, easy to operate, and effective for computer users with simple needs.

Advanced Systems Concepts Inc., \$449

THE ANALOG CONNECTION II

The Analog Connection II from Strawberry Tree Computers was designed for use with Apple II+ and IIe computers. It is intended for use in laboratory and industrial applications, including data logging, process monitoring, and process control. It will measure temperature, pressure, flow, and other analog inputs from voltage or current sources.

The Analog Connection II can switch heaters, fans, and pumps on and off at preset levels or from digital inputs. Users can log data or can display the maximum, minimum, average, or difference of inputs. Alarm limits can be set for any input device, and input ranges and engineering units can be specified through menus. A menu that offers ten different thermocouple one-word types provides flexibility when measuring temperature. Linearization and cold-junction compensation are accounted for automatically. Overall system accuracy is 0.04 percent. High noise rejection is 110 decibels common mode, and 72 decibels normal mode. Ten input ranges, which span from 25 millivolts to 10 volts and 2.5 to 50 milliamperes full scale, accept data from most sensors. The basic configuration of the Analog Connection consists of a single, standard-size expansion board that plugs into an Apple

slot. It has eight analog inputs and eight digital I/O lines. Data acquisition software is provided and the Analog Connection can support as many as 48 analog inputs and 48 digital I/O lines. Options include a battery-backed clock and a terminal box with cold-junction compensation for thermocouples.

Strawberry Tree Computers, \$490

APPLE 9-TRACK TAPE DRIVE

When a business owner wants to buy or rent mailing lists, he or she may be faced with a problem. Few companies offer mailing lists or other data in a medium that is compatible with an Apple. Even the U.S. Government offers its data to users on 9-track tape. Electrovalue Industrial offers a solution to this problem. Their Apple 9-Track Tape Drive is designed to interchange data between an Apple microcomputer and a large mainframe. The package consists of an industry-standard tape drive, an adapter, a controller card and all necessary cables.

The package's documentation is very clearly presented and very technical in content. Included with the instruction manual is a copy of the tape drive manufacturer's technical manual. Electrovalue provides several software programs written in Applesoft to help users get the system up and running. The demo program supplied transfers ASCII files from tape to screen, disks or printer, and vice versa. It handles up to 100 tape files and allows the user to specify block size when transferring from disk to tape.

This is not an inexpensive system, nor is it for the computer neophyte. Nevertheless, for users who need to communicate with other computers on 9-track tape, or who need reliable data backup, or who use Apples for large-scale data correction, this is a very cost-effective alternative to other storage systems.

Electrovalue Industrial, Inc., small drive \$1,800; large drive \$3,000

APPLI-CARD

Appli-Card from Personal Computer Peripherals is a very good card with very poor documentation. This Z80 board for Apple computers comes in two versions, 4 Mhz and 6 Mhz, with 64K RAM expandable to 128K RAM.

Thank goodness the disks supplied are menu driven. This goes a long way toward overcoming their poor installation instructions. In addition to two programs, one to configure SOFTVIDEO and the second to patch CP/M for the drivers chosen, Appli-Card comes with nine standard Digital Re-

search utilities. Up to 128K RAM is available with the RAM extender, an option that costs \$200 and allows you to dump an entire disk into RAM.

A bonus from the Appli-Card for Apple users who lack an 80-column card for display allows them to create a 70-column display by using the high-resolution page. No loss of program space occurs when using this option because the Appli-Card does not use Apple RAM.

Perhaps the biggest drawback to Appli-Card is its compatibility with Microsoft's 280 card. Programs written for the Microsoft card will not run on the Appli-Card; however, it will run all generic CP/M programs.

The Appli-Card lists for \$375. It is also available, bundled with *WordStar*, for \$500. This is a real bargain if *WordStar* is the word processing program that you want to use.

Computer Peripherals, \$375; with *Wordstar*, \$500; 128K RAM EXTENDER, \$1,200

ATARI 5200 TRAK BALL

Without a doubt the most distressing feature of the Atari 5200 is the lack of a quality controller. The potentiometer joystick that comes with the system has many problems. In fact, a contact at Atari revealed that the return rate of the original equipment joysticks is in excess of 25 percent. Some of the most common complaints are that the response is slow, the rubber boot wears out, the plastic knob comes off, and that the stick is not self-centering. Now there is an alternative: the Atari 5200 Trak Ball.

First introduced into arcade halls, the track ball quickly became a favorite among players. It offered a different feel, quick response, and a new dimension in control. The 5200 Trak Ball has all of the traits that made the coin-op controllers popular. Inside the 5200 unit, a white ball about the size of a billiard ball rests on two rollers. When the ball is spun, friction causes the rollers to turn. Attached to the end of each roller is a wheel that has small "windows" spaced evenly on the outer rim. As the ball spins, the wheel turns, and two light sensors are activated as the windows pass in front of them. Using special logic chips, the blips detected by the sensors are converted from digital to analog signals. The Trak Ball senses the speed and direction of the ball and relays this information to the 5200 master control. The designer of the 5200 Trak Ball deserves a medal. For the modest cost of this peripheral, he has turned the Atari 5200 into a truly super gaming system.

Atari, \$79

ATARI-TO-APPLE ADAPTER

Electronic Control Systems has introduced an adapter that allows switch-type (Atari-compatible) joysticks to be plugged into an Apple computer. This is not the first device of this type. The Sirius Joyport did the same thing, but required special programming to use a switch-type joystick. Several companies offered games with a joyport option for about a year, but few new games have been released for it.

Unlike the Joyport, the ECS device makes a switch-type joystick look like a potentiometer to the computer; well, not a full potentiometer, but three positions (full clockwise, center, and full counterclockwise). A knurled rotary control on the side of the box adjusts the resistance of the center position. Such an adapter makes it a joy to play maze games like *Pig Pen* and *Snack Attack*, as well as other games requiring movement in four directions. The ECS device is superior in every way to other devices of this type. Incidentally, it is also vastly over-engineered compared to similar devices; the adapter uses no less than 16Ks, 14 resistors, 5 capacitors, 2 mini pots, and several diodes. With this amount of hardware you could almost build your own computer. However, it works very well, and that's the important thing. Now you can take advantage of the wide variety of joysticks available for the Atari-compatible computers on your Apple and do it in style.

Electronic Control Systems, price not available

AXLON RAMDISK 320

Programs that require a lot of file manipulations and disk access are slowed considerably by the need to wait for the disk drives to turn. Apple computers have particularly suffered from this problem, and would greatly benefit from an electronic disk emulator to bring the information transfer rate up to the transfer rate of data in RAM. To overcome this problem, Axlon Inc. has provided the Ramdisk 320.

The Ramdisk is a stand-alone unit that is about the same size, shape and color as an Apple II disk drive. The package also includes a power cord and a cable that attaches to an interface card. The card can be used in any expansion slot on the Apple motherboard. As the name suggests, it features 320K bytes of RAM as well as its own power supply and battery backup. This is one system that will not lose your data because of a power failure. Ramdisk comes with two database systems, both documented, listed, and modifiable: a utility to enable the extra 40K bytes of memory the unit has and a utility to manipulate certain text files faster.

The speed advantage of this Axlon unit is impressive. In prolonged testing it proved to be both reliable and accurate. Its documentation is well presented and relatively clear. It even offers a well-annotated assembly code listing of its programs. Notwithstanding its price, the Ramdisk 320 may be the best disk emulation package around for the Apple computer.

Axlon Inc., \$995

BABY BLUE CPU PLUS

Now that you have moved up to an IBM PC, what do you do with all of your CP/M programs? Do not despair—Xedex has come to the rescue with the Baby Blue CPU Plus, an 8-bit processor board that will keep your CP/M software running.

The Baby Blue card consists of a printed circuit board with 64K of RAM and its own Z-80B microprocessor. Included in its package are three software programs called *Header*, *Bind* and *Convert*. *Header* must be added to the beginning of each CP/M-80 program in order for it to run on Baby Blue under the PC-DOS operating system. Either *Bind* or *Convert* will attach *Header* to the beginning of CP/M-80 files. *Convert* will, additionally, convert the file to the PC-Dos format. From that point on, the user can invoke the CP/M-80 program just as if it were a program written for the IBM PC.

Installation of Baby Blue is a very simple procedure made easier by the wonderful instruction manual supplied with it. Perfect photographs lead the user through each procedure. The text is well-written and straightforward.

The Baby Blue will run most but not all CP/M-80 programs. It will not run CBASIC, but it is compatible with all software that is hardware-independent. At this point it should be noted that Baby Blue does not run CP/M-80; it emulates CP/M. The CP/M-80 operating system and its utilities are not included in the software package.

The Baby Blue is a good way to save your CP/M programs on the IBM PC. It is easy to use and performs as advertised.

Xedex Corporation, \$600

BUBDISK

The one problem with random access memory is that it is volatile—if you lose power in the middle of a session, you also lose all the data in memory. MPC Peripherals has made that a thing of the past with BUBDISK.

The BUBDISK is a 128K memory module designed to plug into the Apple II. The big difference

between BUBDISK and other RAM expansion boards is an Intel 7110-4 bubble memory device. Its key feature is protection against power failure: Bubble memory modules are non-volatile.

Installation of the BUBDISK is fairly simple, despite the rather skimpy instructions supplied by the manufacturer. The software supplied is called BUBDOS. It is a patched version of Apple 3.3 DOS, and it works just fine.

An entire Apple floppy disk can be copied into bubble memory. The user can then work at RAM speeds on formerly disk-based data. Unfortunately, the BUBDISK cannot get access to programs that use copy-protection measures.

While its documentation leaves something to be desired, the BUBDISK is a very well-made, easy-to-use product that will enhance many Apple II operations while providing a measure of protection against power failure.

MPC Peripherals Corporation, \$895

THE BUSBOARD

The Busboard, a multifunctional board, holds out the promise of all good things, but may be a well-disguised trap.

The Busboard comes unpopulated (except for 256K RAM) with sprockets on both sides, and each side has a separate bus. Offered as options are 512K bytes of RAM, an asynchronous port, a parallel port, a clock/calendar with 10 alarm settings and software called *Bustime* to automatically schedule your computer's operation, a game port, a 300-bit-per-second auto-dial modem, a 280Z coprocessor for running CP/M programs, a 6502 coprocessor for running Apple programs, and a graphics controller capable of 16 colors. All these features are not yet available, but enough are to start the program.

Heat kills computers, and heat is what you will get. A fully populated board will look like something out of the space program without the benefit of outside subzero temperatures. LNW Computers' own manual warns of this problem. The Busboard is not easy to install. The experienced as well as the fainthearted should use the services of a good and reliable dealer. The semi-populated board worked well enough and the manual provided was clear and comprehensive. But one wonders what will happen as time goes on and more modules are added.

LNW Computer Corp., \$900 with clock/calendar, serial and parallel ports, game port

THE BUSCARD

The Buscard is a general-purpose interface for the Commodore 64 computer. It is designed for those users who have access to peripherals not readily usable with the 64. Earlier Commodore computers, the PET and CBM series, were built around the IEEE-488 interface bus; Commodore disk drives and printers matched this data standard.

The Commodore 64, however, uses the same unique serial interface scheme as its less powerful predecessor, the VIC-20. Interfaces are required for any device not built around this serial bus structure.

In effect, the Buscard is really two interfaces in one. Not only does it adapt any Commodore peripheral using the IEEE-488 standard, but it can also be used to attach printers requiring (Centronics) parallel data. Physically, this interface is packaged in a small (about 4 by 6 inch) slim (less than an inch) plastic box with circuit card edge connectors. It plugs directly into the computer's cartridge slot.

A printer and the first IEEE-488 device are connected to the Buscard via ribbon cables. (It accepts the standard cable used with the Commodore 4040 and 8050 disk drives, which are much faster than the 1541 drive designed for the 64. To use a parallel printer, a special cable is required but not furnished with the Buscard.) A small row of DIP switches on the box selects which peripherals will use the Buscard and which will remain on the 64's serial bus. Additionally, a connector located on the top of the plastic box extends the cartridge slot so that it can still be used.

The Buscard works by switching out part of the computer's operating system, known as the Kernel, and replacing it with new ROM routines that drive the additional peripherals. Because of this, Buscard's designers were able to add some additional power to the version of BASIC built into the 64. Thirteen new words are offered: APPEND, BACKUP, CATALOG, COLLECT, CONCAT, COPY, DCLOSE, DLOAD, DOPEN, DSAVE, HEADER, RECORD and RENAME. Veteran Commodore users will recognize these as the main features of CBM 4.0 BASIC.

Any opinion of the actual performance of this interface is subject to the application it is put to. It does, in fact, do everything as promised. Problems come, however, with commercial software that has been specially protected against piracy. While many such copy-protected programs loaded correctly using a 4040 disk drive and the Buscard, some didn't. (Specifically, these include programs

from Electronic Arts.) Reportedly, the device also runs into snags when running some programs packaged on ROM cartridges.

Two other annoyances surfaced while testing the Buscard. The most minor was the inconvenience of installing the interface, which requires opening the computer and attaching two wires (via "klep"-style clips) to connections on the main logic board. While this is a simple matter, it is probably not recommended for those not technically inclined.

The other problem came as the computer "warmed up." On some computers—particularly early versions of the 64—the Buscard appears to draw more power than can be comfortably accommodated. The symptom shows up as distortion on the video screen.

In general, the usefulness of the Buscard depends on how much you need what it offers and whether or not you can live with its limitations. In fairness, the Buscard is better than most IEEE-488 interfaces, even though it has problems with certain software.

The main reason to use this or any other IEEE-488 interface is to take advantage of the speed of Commodore's other disk drives. The Commodore 1541, the standard drive for the 64, is agonizingly slow. But no interface tested so far accomplishes this trick without sacrificing some software compatibility.

Buscard, \$199 Batteries Included

BYAD'S DS

Byad makes a fine 8-bit coprocessor that fits right into an IBM PC expansion slot. The DS1 is a printed circuit board that contains a Z-80B microprocessor and 64K of RAM. The package comes complete with CP/M-80 and all of its utilities. Byad also offers the 2.2 version of CP/M and a greatly enhanced version called CP/M-80 Plus.

Also included in the package are three Byad programs called Transfer, Filex, and Setup. Transfer allows the user to capture data coming through the IBM PC's serial port. Filex lets you read into DS1 format 5¼-inch disks in other formats, such as Tel-evideo, Cromemco, Interdec, and others. Setup configures the system after the DS1 board is installed. Among other things, Setup lets you enhance CP/M by setting aside some of the PC's memory to serve as disk buffers, a print buffer, a serial-in buffer and a serial-out buffer. You can also choose to have the DS1 emulate one of three different terminals: the DEC VT-52, the Lear Siegler ADM-31, or the Heath H-19.

The documentation supplied is only adequate and the installation of the board is awkward, to say the least. All other expansion boards must be removed prior to installation of the DS1. All memory chips above 64K must also be removed. Once it is set up, the board works very well indeed. A big bonus with this system is that it includes a license for CP/M—this entitles its owner to all CP/M updates.

Byad, Inc., \$660

C-64-LINK

Richvale Telecommunications now offers Commodore 64 owners a way to give your machine a number of features normally found only on the more expensive PET/CBM series of microcomputers—the C-64-Link. Unlike other interface devices, the Link has no switches to set. It simply plugs into the cartridge port and provides BASIC 4.0 features at power up. The C-64-Link gives you an IEEE 488 bus interface so that you can use any PET/CBM peripheral, such as the 4040 or 8050 high capacity drives. You can even intermix serial, parallel, and IEEE peripherals when they are all connected to the Commodore 64. Additional BASIC commands are added to the operating system to allow the selection of peripheral interfaces that are to be used. Once the C-64-Link is installed, all you need is a standard PET-to-IEEE cable to connect the first IEEE peripheral. Standard IEEE-to-IEEE cables can then be used to daisy-chain additional devices.

Besides the additional interfaces, you also get a number of new BASIC commands normally found in the BASIC 4.0 in the PET and CBM systems. This includes the 16 DOS commands as well as a built-in machine language monitor. The ability to use the IEEE-type disk drives on the Commodore 64 proved to be a real pleasure when compared to the VIC-1541 serial interface drives. A 20K program takes about 40 seconds to load from the VIC-1541. The same program took only 10 seconds to load from a 4040 drive with the C-64-Link.

Richvale Telecommunications, \$169.95

CAPTAIN

Like many multifunction boards, the Captain from Tecmar can increase the capability and utility of your IBM PC or XT. It adds 384K of RAM to the 256K available on the IBM motherboard, bringing the system to its 640K maximum. Captain also adds parallel and serial ports, a battery-backed clock/calendar, and a facility for a PAL (programmable

array logic) device. This entire package slips into one expansion slot on your IBM PC.

The board is well constructed and it arrives with complete documentation for installation and for using the included software. *Ramspooler*, Tecmar's print buffer software, delegates a user-defined portion of the system RAM to print-spooling. It can be used with either parallel or serial ports. *Speedisk*, a disk emulator program, permits allocation of memory to a virtual disk drive that operates many times faster than a floppy. The clock/calendar uses Tecmar's *Auto Time* software to set the time and date whenever the system is powered up. A back-up battery maintains the correct time and date with the system's power turned off for up to a year. The battery can be easily replaced without tools.

The Captain is a mature product from a fine company. Both the hardware and software are a cut above average. Installation is a simple matter: Slip it into any slot, and you are up and running. Tecmar designed the Captain specifically for the IBM XT, and all tests were run on the XT. It also claims compatibility with both the IBM PC and the Compaq.

Tecmar, Inc., \$795 to \$880

COCO-COOLER

Even during normal use, the large transformer inside of the TRS-80 Color Computer gives off a great deal of heat. If you leave the computer's power on for any length of time, its case becomes quite warm to the touch. This heat is not healthy for the delicate electronic components inside the Color Computer. The Coco-Cooler from Rem Industries is a low-cost solution to this problem.

Made of high-impact black plastic, the Coco-Cooler sits on top of the TRS-80's vent holes at the left rear corner of the case. Installation of the unit is so simple that even the least mechanically-inclined user should be able to accomplish it without a problem.

The Cooler has an independent on/off switch that allows you to shut off the fan but continue to use the computer. The fan does not draw current from the computer; instead, it has its own seven-foot power cord.

The Coco-Cooler makes very little noise. If you turn on the unit when you turn on the computer, you will notice that the computer's case never becomes the slightest bit warm. On the other hand, if the computer starts to heat up and then you turn on the fan, the machine will cool to a satisfactory temperature in minutes.

Rem Industries, Inc., \$39.95

COLBY COMPUTER SYSTEM MOTHERBOARD

Did you ever want to build your own IBM-compatible computer? Colby Computer gives you the opportunity to do so with its single-board Computer System Motherboard.

The Colby Motherboard has an 8088 microprocessor that operates at 4.77 MHz. It comes with 64K of RAM, one RS-232 serial port that operates at 50 to 9600 baud, a keyboard port, a 5¼-inch floppy disk controller that uses a 34-pin cable, five expansion slots, a speaker port and a real-time clock with a battery back-up. All of these features are IBM-compatible.

Options available for the board are: up to one megabyte of RAM in either 64K or 256K chips, 40K of EPROM or ROM, an 8087 coprocessor and a faster main CPU. One option that is not yet available from Colby is a video controller board. It can be bought from other sources.

The Motherboard will pose no problems for any experienced hobbyist trying to turn it into a full-fledged computer. The instruction manual is complete, and it offers many tips that make the job easier.

Colby supplies its own BIOS on ROM, and this supports MS-DOS, PC-DOS, CP/M-86. The system runs most, but not all, IBM PC software. Any program that uses the IBM PC-BIOS will not run on this system.

Colby Computer, \$799

COLOR MOUSE

A mouse is a popular cursor-control device used mainly on such high-end computers as the IBM PC and Apple Lisa. On these machines, the mouse is used primarily with serious application software.

Radio Shack seems to have other things in mind for its Color Mouse. Not many sophisticated application programs for the Color Computer require delicate cursor control, but a lot of games do.

The Color Mouse is essentially a track ball, like those found on many arcade games, turned upside down and with a button on top. The user controls the cursor by rolling the Color Mouse in the desired direction—forward for up, backward for down, left for left, and right for right.

A steel ball is the mouse's main moving part. It rolls on a flat surface in a 4.5 by 4.5 inch square. Radio Shack suggests that a clean piece of paper be placed under it while in use to prevent dirt from entering the mechanism. The user is also advised

to not touch the ball. A child probably would not pay much attention to these warnings, so the Color Mouse could have a short lifespan in a child's hands.

Only certain types of games are enhanced by the use of the Color Mouse. It does the same kind of things as a joystick and improves accuracy. Only a very avid game player could justify buying the mouse.

Radio Shack, \$49.95

COLOR PLUS GRAPHICS ADAPTER

An alternative to the IBM Color Graphics Adapter is Plantronics' Color Plus Graphics Adapter, two boards fastened together that occupy one IBM PC expansion slot. The Color Plus handles the same functions as the IBM board, plus it gives you a parallel printer interface.

The Color Plus board is shipped with installation instructions and a software package called the *Drafts Man* that produces line, pie and bar graphs with associated text. An optional cable connects with a standard television set. The standard-size circuit board has a 9-pin connector for an RGB monitor and a 25-pin connector for the parallel printer interface. A connector for a light pen is also provided. The heart of the board is a Motorola 6845 CRT controller chip that serves up to 32K, twice as much as IBM's board.

Color Plus offers an extended color graphics mode that allows 16 colors to be displayed simultaneously in medium resolution. The IBM board allows only one of two predetermined color sets plus any one of 16 background colors.

Unfortunately, the documentation supplied by Plantronics is, in a word, terrible. Skimpy, disorganized and poorly written operating instructions give little help to the user.

The board did not work with a standard color television; the TV image was unstable and filled with a regular, snowy interface pattern. It did work well on the IBM color monitor.

Plantronics, \$475

COLORMATE

ColorMate is a multifunction board for the Radio Shack Color Computer. It increases Coco's RAM to 64K and provides a disk controller, a ROM-pack port extender, and a real-time clock.

The disk controller can handle up to four 5¼-inch floppies or one hard disk. It reads Radio Shack Color Computer disks and uses the SDOS

operating system. Capacity for a 5¼-inch disk is 100K.

The ColorMate port extender plugs into the ROM-pack port. One serial port and one Centronics-standard parallel port are provided.

The clock/calendar does not have a battery backup and is only accessible through software. You must enter the date and time whenever you boot up.

The ColorMate's software package includes SDOS, a BASIC compiler, a 6809 assembler, a text editor, and utilities. The documentation for all of this is poor. You will be able to install and learn how to use the ColorMate yourself, but you will have to spend a lot of time searching through its manuals to accomplish this.

Computer Systems Distributors, \$495

COLORSPEAK

Colorspeak is a speech synthesizer for the Color Computer based on the popular Votrax SC-01 chip. It comes in a cartridge that plugs into the computer's ROM port. Its voice comes through the TV's audio circuitry. Colorspeak has an advantage over software-speech synthesizers in its accuracy and flexibility.

The user can use any of four methods to get speech out of Colorspeak. The program can pronounce individual letters, numerals and punctuation marks; the user can specify hexadecimal phoneme codes; the text can be spelled out phonetically; the user can enhance the phonetic spellings with a set of inflection codes.

The hexadecimal phoneme codes produce the best speech, but they look nothing like written English. Phonetic spelling can look foreign, too, but it appears much more familiar than the hexadecimal code.

The unit is easy to use, and its instructions are sufficient to get the novice started. At \$169, though, this is not likely to become a hobbyist's toy. Colorspeak does have practical uses, such as aiding the visually impaired. The manufacturer offers a 10 percent discount to vision-impaired purchasers.

Bumblebee Software, \$169

COMBO II CARD

The Combo II Card is a multipurpose card that features a parallel printer adapter, an asynchronous RS-232 communications adapter, a battery-backed clock/calendar, and a game adapter. It fits into one IBM expansion slot. None of the functions

of the Combo II Card require any special software drivers, and all IBM PC software operates with the card without any modifications.

The printer connector is compatible with IBM's printer cable. A diskette is provided for the clock/calendar with programs that allow the user to set the date and time and to patch PC-DOS to accommodate the clock. The game adapter can handle Apple and IBM joysticks. To connect a mouse to your system, you can use either the RS-232 port or the game port.

This is a simple expansion board that is both easy to use and easy to install. It doesn't come with much documentation, but not much is needed. The Combo II Card carries a one-year limited warranty.

Apparat, \$189

COMMANDER KEYBOARD

It has been a long time since the Atari 400/800 computers made their debut. At first, Atari was very tight lipped about their machines. In fact, most people were unaware of either the components that made up their home computer or the power that lay beneath the keyboard. Then, hardware modifications became available. This growth in aftermarket hardware products was spurred on by Atari themselves, who by then published the specifications and schematics for the computers in the form of a hardware manual. The Commander Keyboard from Ralston-Clearwaters Electronics stands out amid the recent avalanche of new products for the Atari computers.

There are several useful features on the Commander Keyboard. At the lower left corner of the keyboard are three keys labeled L, S, and R. These are macro function keys and represent three separate functions—List, Start/Stop, and Run. In addition, there is a separate numeric keypad which is handy for entering data. A built-in calculator is also provided. There is a slide switch underneath the keyboard which enables the calculator function. When the calculator is on, a green LED lights up, and you can do math without disturbing your program.

The addition of a detachable keyboard to the Atari computer is really a professional touch that may not be required by everyone. However, if you do a great deal of typing or entering data, you should definitely consider this quality product.

Ralston-Clearwaters Electronics, \$199.95

COMPU/TIME CT 256-1

The Compu/Time CT 256-1 is an IEEE-696 S-100 dynamic RAM memory board that can accommodate

64K to 1 megabyte of RAM. Its on-board memory management scheme allows an 8-bit microprocessor to address a full megabyte of RAM. Memory mapping can be done on either 16K or 64K boundaries. The board also supports 24-bit addressing lines and Phantom Error and Trap options. Parity errors can be examined on an input port. The board's dynamic RAM refresh is controlled by a DP8409 DRAM controller chip. No more than three CT 256-1s may be used in any one computer system.

GSR Computers, \$400 to \$750

COMPU/TIME UNIVERSAL FLOPPY DISK CONTROLLER I

The Compu/Time Universal Floppy Disk Controller I (UFDC-1) is an S-100/IEEE-696 board that can connect up to four floppy disk drives. These drives may be any combination of 5¼-inch or 8-inch with ANSI-standard interfaces, single- or double-density formats, and single- or double-sided drives.

Based on the Western Digital 1795 floppy disk controller chip, the UFCD-1 uses wait states to synchronize the processor for disk transfers. Data transfer, status checking, drive selection, density, disk side and wait state are all controlled by external I/O control and status ports. The UFCD-1 also uses the 9216 Digital data circuitry to write precompensation and read data separation. A synchronous clock distribution scheme synchronizes the 1795 and all data circuitry clocks.

A unique feature of this S-100 bus controller is its ability to read to and write from differently sized and formatted disks. This is accomplished by having the CP/M boot program in ROM and the CP/M disk translation tables on the disk sector that normally contains the boot program. In addition to various standard formats, the UFCD-1 can handle user-created formats.

The UFDC-1 comes with a user's manual and an 8-inch, single-sided, single-density CP/M disk that contains the Moniton/Bios and Disk Formatter source listings. This is truly a useful tool for the experienced user.

GSR Computers, \$325

COPY SYSTEM

Disk reproduction has always been either a slow but affordable process or a very fast, expensive one. As more and more computer users recognize the need for reliable disk reproduction, a middle ground becomes increasingly necessary. ALF Products may have solved the problem with Copy System.

The Copy System comes with Power II (a high-current power supply), a clock modifier module, disk software, and a completely understandable owner's manual. Designed to operate with the Apple II or Apple II+, the Copy System is capable of working with two to ten Apple disk drives. After disconnecting the Apple's internal power supply, the user hooks the Power II up to the power connector on the Apple's motherboard so that the power switch on the Power II controls power to the computer. A switched outlet is provided for connecting a monitor. The Copy System's software checks the rotation speed of each disk drive in the system. If the speed is out of a specified range, it must be adjusted. No other modifications to your system need be made.

Operation of the Copy System is simple. All software is supplied on a 13-sector (DOS 3.21) disk and can be moved onto a 16-sector (DOS 3.3) disk, if desired. The copy program is started by typing "BRUNCOPY." The disk to be copied is then placed in a drive designated as the "master" drive, and blank disks are placed in one to nine "slave" drives. Pressing the space bar begins the copying process. From 97 to 207 copies can be made per hour. Altogether, this is a workable, easy-to-use system.

ALF Products, Inc., \$995

THE CONNECTION

Don't run out and buy a Commodore printer for your C-64—at least, not just yet. First consider the advantages of connecting a Centronics parallel printer to your system. Think about the proven quality of an Epson or Okidata printer. Then, think about the Connection from Tymac Controls that will make it all possible. With the Connection you can make an FX-80 behave just like a Commodore 1525, right down to the special graphics characters.

One end of this connection interface plugs into the daisy-chain serial connector of the computer or disk drive, the other into the Centronics connector on the printer. It can be assigned any device number and will provide virtually total emulation of Commodore printers. It supports all of the standard commands as well as providing features that a Commodore printer will not. The connector includes a 2K buffer, printer self test, LED status indicators, reset switch, skip-over perforation mode, and programmable line length.

Special ROM versions of the Connection are available for all popular printers. It is important to buy only the version for your machine so that the

graphics will print out correctly. The Connection performed flawlessly on an Okidata 92 in our tests. Its renditions of special Commodore graphics characters are even more legible than those put out by the Commodore 1525. Margins can be set to make listings match screen width. And if you wish, English tags can be substituted for special graphics characters. All in all, the Connection is worth considering if you require a better quality of printer than that offered by Commodore.

Tymac Controls, \$130

CP/M CARTRIDGE

CP/M is now a standard, and many manufacturers supply it as a primary operating system on their computers. In order to ensure a large program library for new computers, many other manufacturers are offering CP/M as an optional secondary system. When Commodore introduced the C-64, they listed CP/M as an alternate system. As with many manufacturers there was a long delay before Commodore made CP/M available. The C-64's CP/M is version 2.2. There is no indication that Commodore will offer the later 3.0 version in the near future.

Commodore C-64 CP/M consists of a cartridge that plugs into the computer's cartridge slot and a diskette containing the operating system. The system disk contains the standard CP/M files, including ED, STAT, OPT, PIP, etc. The Commodore user's manual is a condensed version of Digital Research, Inc.'s CP/M manual. There are a great many errors as well as omissions in the Commodore version. Most of them can be resolved, but the user should not have to put up with that. This is a quick and easy way to have a CP/M system on line and running. It does have its limitations, though. If you want to program in BASIC, you are in trouble. BASIC is not included, nor is any other language except Assembly. Still more problems exist with the Commodore diskettes. You cannot put some other supplier's disk in your system and run it, or for that matter, even copy a program.

Commodore Business Machines, Inc., \$59.95 to \$79.95

CPU 68 K

The CPU 68 K is a 10 MHz Board based on the 68000 microprocessor. It can address a full 16 megabytes of nonsegmented memory through an IEEE-696/S-100 bus. Manufactured by CompuPro, the CPU 68 K handles both 8-bit and 16-bit memo-

ries and enables mixing of both types in the same system. The board can change from full-speed to half-speed operation with a simple jumper change.

The CPU 68 K includes a socket for a 68451 memory management unit and sockets for up to 16K of EPROM. It accepts 2716-, 2732-, or 2764-type EPROMS.

An on-board wait state generator accommodates all types of machine operations, and as many as five waits can be added to any cycle. An on-board interrupt structure works with either the internal vector-generation circuitry or an external source.

Fully compatible with CompuPro's entire IEEE-696/S-100 bus product line, CPU 68 K can share the bus with CompuPro slave processors to run 8-bit or 16-bit programs. CompuPro's software for CPU 68 K includes CP/M-86 K and an advanced FORTH operating system. The latter includes a complete macro assembler and a full set of utilities that allow users to read and write CP/M files. Users can create programming tools from existing CP/M or CP/M-86 files.

It is usually safe to say that when CompuPro offers a product, you can assume it does what it's supposed to do. The CPU 68 K is no exception to this rule. It is a fine, well-documented product that will serve its purchaser well.

CompuPro, \$850

CPU 286 BOARD

The nice thing about S-100 based computers is they do not become obsolete. This has been proven once again by Godbout Electronics. Their Compupro Division has come up with the CPU 286, an S-100/IEEE-696 CPU board based on Intel's iAPX/10 microprocessor.

The CPU 286 features sockets for an 80287 math coprocessor and up to 16K of EPROM. It is completely compatible with code written for Intel's 8088 and 8086 microprocessors. The CPU 286 has a clock speed of 6 MHz. A clock-switching circuit permits 8-bit or 16-bit slave processors to run on the same bus at various clock rates without time conflicts; this allows users to execute alternate software libraries.

With its 24-bit address bus and 16-bit data bus, the CPU 286 can have access to as much as 16 megabytes of on-line system memory without any segmentation. The unit's on-board logic can also read or write two bytes serially to simulate 16-bit operation with 8-bit memory or I/O. It also incorporates a memory management unit that facilitates high-speed, multi-user, multi-tasking operations as well as memory protection for each work station.

CPU 286 is an exceptionally fine product that comes with full documentation that is carefully written and presented in a logical sequence. It is not an inexpensive peripheral, but it gives excellent value for the money.

Compupro Division, Godbout Electronics, \$1,595

CRT IMAGING OUTFIT

You have just generated a fantastic, 3-dimensional color pie chart on your computer's RGB monitor. It is something that the whole world should see. Somehow, the black-and-white dot matrix printer just won't do justice to your creation. How do you capture that colorful image for posterity? One solution might be the Kodak Instagraphic CRT Imaging Outfit. This low-cost unit creates instant prints from images on your computer display in regular room light. You can also use it with your 35 mm camera to produce slides.

The instant prints have the quality of, well, instant prints. They lack some of the snap and definition seen on the RGB monitor, and there is a color shift. Overall, the results are pleasing enough and usable for most applications. Slides taken from the 35 mm camera are of much better quality.

Actual installation will vary depending on your monitor and other considerations. However, in all cases it will be a large pain. There are brackets, bumpers, and foam strips that must be used to achieve a proper fit to your monitor. In some cases, you may need a small coping saw to do a safe and neat job. Clearly, it was Kodak's intention that this product be available for use on a wide variety of monitors. But its ability to work with many different types of cameras is the real bonus with this system. Installation problems aside, this is a fine, well-documented product that is being sold at a fair price.

Eastman Kodak Co., \$190

CYGNET COMMUNICATIONS COSYSTEM

The Cygnet Communications Cosystem takes up only a little more space than a telephone, but it provides a much greater range of communications. The Cosystem is designed to work concurrently with the IBM PC. It provides a large array of features: a telephone, an auto-dial/auto-answer modem, sophisticated communications software, concurrent operating system capabilities, a data buffer, and PBX (private branch exchange) functions.

The system contains its own Z-80 microproces-

sor and 90K of RAM, including 64K of battery-supported CMOS RAM for storing messages. While the user performs normal operations on the IBM PC, the Cosystem will automatically receive and send messages. The Cosystem can automatically dial telephone numbers from a directory of 400 names. If a number is busy, the Cosystem will redial it. A builtin text editor allows you to compose messages, and a clock/calendar lets you schedule appointments and generates reminders for you.

Communications Management software facilitates unattended sending and receiving of electronic mail. It also allows the Cosystem to emulate 15 common terminals, and it supports file transfers. The Cosystem permits simultaneous spoken and textual communications as well as three-way teleconferencing.

Cygnnet Technologies, 300 BAUD \$1,495; 1200 BAUD \$1,845; Speaker phone \$150

DASH-1

Dash-1 is a hardware and software package that allows electrical engineers to display and revise schematic designs. It requires an IBM PC with 256K of RAM, two double-sided, double-density disk drives, a parallel port, and a monochrome display. Dash-1 includes software configured for a C. Itoh 15-inch ProWriter printer.

The Dash-1 package consists of a graphics controller card, a mouse, and software. The graphics controller has 640 by 360 resolution and a port into which the mouse is plugged directly. The three-button mechanical mouse is used to position the cursor and to make graphics selections. The first button on the mouse defines the end points of lines that represent circuits. Once the end points are established, a line can be drawn between them. The second button creates interconnects (a type of circuit junction). The third button deletes line segments.

The software consists of a graphics editor and library programs. Elements can be pulled from the library and manipulated on the screen to create electrical diagrams. New symbols and part designations can be added to the library. The program automatically checks for and warns the user of such common errors as dangling interconnections or inputs with no outputs.

This is a well-made, well-designed product that serves a useful purpose for one segment of computer users.

Future-Net Corporation, \$4,980

DATA DEFENDER

Automobiles and computers are both expensive, mobile, and highly resellable items. And just as automobile owners have had to install elaborate security systems to keep their cars in the driveway, computer owners must now do something to keep their computers in the den. Data Defender does not defend data. It defends computers and like equipment weighing more than five pounds against theft. Attempted theft is detected through the use of a pressure mat placed under the computer. When the computer is lifted from the mat, two 100-decibel horns go off.

The system is designed to be resistant to circumvention. An internal battery sounds the horns not only when the mat switches open but also when the wires connecting the control module to the mat are cut. The battery also keeps the system operational if the line power is cut off. An LED indicates system arming, and a test function is provided. As additional protection, the horns will sound to warn of low batteries. In tests, the Data Defender proved true to its claims. The horns blared with an intensity guaranteed to wake a mummy. If you sleep more heavily than that, optional outside horns are available.

PICOtronics Inc., \$189.95

DATACOMM CABLE TESTER

If you are a computer dealer, you will be interested in a tool from Datacomm that will help you to satisfy your customers. If you are a user of many computers, you can use this same tool to reduce down time.

The Datacomm RS-232C cable tester is a pocket-sized, battery-powered unit that tests and verifies cable configuration. Cables can be tested in either test or scan mode, and the tester has 50 LEDs that correspond to connections on each end of the cable. Three additional LEDs indicate open, short, and continuity states for each connection of the cable under test. Cable connectors are of the dual male/female 25-pin D-type. They allow any configuration of RS-232C cable connections to be tested. The remote indicator lets you test and verify operations on installed cables.

The Datacomm cable tester performed flawlessly in tests conducted for this review. This is a good, lightweight package (11 ounces) that can save you a lot of computer down time.

Datacomm Northwest, Inc., \$399

DATACOPY MODEL 90

Datcopy's Model 90 allows its user to transfer images to an IBM PC or XT. It consists of an electronic digitalizing camera, an interface board and such accessories as a camera power supply and cables.

The electronic camera (Datcopy's Model 610) lets the user enter photographs, documents and images of three-dimensional objects into a personal computer without using a keyboard. The camera captures an image through a standard 35-mm camera lens. Inside the unit, a linear array of 1,728 solid-state photo-sensors scans the image and translates it into computer-readable digital code. This code is then organized into a two-dimensional matrix of 4.9 million pixels. The gray-shaded image can now be displayed, printed out, or stored in the computer's memory.

The camera requires little light, even when capturing Microfiche, drawings, or printed text. The interface board is easy to install, and the software that is provided works very well. The package's documentation is positively massive. No detail of this excellent product is left to chance. Images produced on the computer by the unit are of superior quality, and, while not suitable for framing, they are certainly some of the best around.

Datcopy Corp., \$9,945

DCP/88

PerSyst's DCP/88 distributed communications processor permits IBM PC and XT users to perform HASR/RJE (Houston Automatic Spooling Program/Remote Job Entry) functions in conjunction with IBM mainframes. The DCP/88's 5088 microprocessor sends and receives all data while the PC executes programs. DCP/88 can also function as a parallel processor for program or subroutine execution. It supports 64K of dual-processor RAM and can accommodate asynchronous, bisynchronous, HDLC and SDLC line protocols. The DCP/88 requires one PC expansion card slot.

PC/HASP software, supplied with the board, can support up to seven multileveled input and seven output job streams concurrently. As many as six reader streams and six printer/punch streams can be initiated from the PC console. Centronics- and Data Products-compatible printers that print up to 600 lines per minute are supported, and print data can be spooled to disks for off-line printing. Up to 128K of RAM are available for this feature.

DCP/88 can emulate an IBM 3274 Cluster Control Unit and 3274 terminal. This allows it to handle up to four additional devices (a printer and three other

PCs functioning as 3278 terminals). It can also allow your PC to emulate a 2780/3780 remote job entry terminal, which can send and receive batch files to and from the host.

The documentation and software are as good as one would hope for with such an expensive product. The DCP/88 is meant for office and industrial settings; it was not designed with the novice in mind.

Personal Systems Technology, Inc., \$1,690

DELUXE JOYSTICK

Any serious game player takes joysticks seriously. For many, the standard Radio Shack joystick just isn't good enough. The Deluxe Joystick is head and shoulders above the standard version, and it should satisfy even the most jaded game player.

The Deluxe Joystick has a bigger base than the regular ak unit. It doesn't fit quite as nicely in the palm of the hand, but its improved feel and control more than make up for this. The fire button is on the top left of the base rather than on the front side, as it is on the standard joystick. The player easily adjusts to the fire button's new position.

The greatest advantage of the Deluxe Joystick is that it is adjustable. It has two switches on the bottom that toggle automatic horizontal and vertical centering on and off. Two controls on top of the base let the user tailor the joystick's sensitivity to the requirements of particular games.

The Deluxe Joystick has a rugged feel. It comes in an off-white color to match the Color Computer. Although it costs more, it should hold up under heavy use much longer than the standard version.

Radio Shack, \$39.95

THE DIAMOND-3

The Diamond-3 allows you to run 8-bit software on your IBM PC. It is a standard-size plug-in expansion board that fits into any slot on the IBM PC motherboard. It contains three microprocessors: a Z-80A for CP/M, a 6502B for Apple mode and a separate 6502B display controller. The display controller provides a better quality screen output than the Apple II. Apple joysticks can be used with the Diamond-3.

The Diamond-3 serves up 64K of dynamic RAM, 18K of static RAM and 4K of ROM. It will support monochrome, RGB or composite display monitors. It also supports upper- and lowercase characters. Unfortunately, at this time, the board offers a display format of only 24 lines by 40 columns. The manufacturer says that the Diamond-3 will soon

support the much-needed 24-lines-by-80-columns display as well.

The board works well with all CP/M and Apple programs, and its operation is transparent to the user. Its documentation is easy to understand. If Diamond Computer Systems keeps it word and delivers the upgraded display, this board will be a great addition to the IBM PC. They have not announced whether or not this upgrade will be available free of charge to Diamond owners.

Diamond Computer Systems, Inc., \$695

DITHERTIZER II E

The Dithertizer II E is a highly specialized interface card designed for the Apple IIe. This card, along with the supplied software, allows the user to digitize analog input from a video camera. The digitized image can then be displayed on the computer system's graphics screen. Once the video image has been converted, it can be saved on disk or printed on a graphics printer.

Testing of the dithering process (set for the highest number of grey levels) produced an image that looked like a half-tone photograph. The number of grey levels (1 to 64) is set by the numeric keys on the keyboard. The speed of the process depends upon the number of grey levels selected; the process takes one-sixtieth of a second per frame, and each grey level requires overlaying a complete frame. In addition to producing conventional images, the software can do contouring. Contouring allows only the outline of an image to be displayed and yields interesting effects. Included with the Dithertizer package is a printer dump utility that allows you to get printed copies of graphics images displayed on the Apple screen.

The Dithertizer II E is not for the computer beginner. Indeed, it would be wise for the experienced user to seek the aid of a competent local dealer. Some technical support is supplied by the manufacturer.

Computer Stations, \$649

E RAM 80

In the rapidly expanding world of computer add-ons, users have learned to save expansion slots by using multifunction boards. Apple IIe users have not been able to take advantage of these multifunction boards as much as the owners of some other personal computers.

The E RAM 80 from Quadram does double duty for the Apple IIe. It is a low-cost enhancement card that doubles the amount of text that can be dis-

played on the Apple IIe's monitor screen while also doubling the computer's memory. An E RAM 80 allows the Apple IIe user to switch back and forth between two formats: standard 40-column and the extended 80-column display. When the 40-column format is used, E RAM 80 provides 654K of RAM for auxiliary memory in addition to the 64K already installed on the motherboard. With the extended 80-column format, 1K of RAM is used to store the extra characters, leaving 63K available for auxiliary memory.

It's easy to use and easy to install, and the E RAM 80 brings two functions to the Apple for the price of one. This is a quality product from a mature manufacturer; you should have no trouble buying it off the shelf and setting it up yourself.

Quadram Corporation, \$159

EAGLE COLOR/GRAPHICS BOARD

The Eagle PC, Eagle 1600 series, IBM PC and most IBM PC-compatible systems can have color power with the Eagle Color/Graphics monitor adapter board.

Designed to work with a large variety of color and monochrome monitors, it is indeed the solution to many compatibility problems. The Eagle Color/Graphics board has a high resolution (640 × 200) monochrome display. Tests run on an Eagle and IBM PC gave crisp clear letters and numbers and scrolling was not unpleasant. Offering reverse video and blinking and highlighting features in the monochrome mode lends extra versatility to the system. When operating in the color mode, 16 foreground and 8 background colors in a medium resolution (320 × 200) display are available, along with character blinking.

The documentation is far above that which is usually supplied with an expensive board of this type. Carefully follow the clear instructions and the system will be operating in minutes. If you have been shopping for a color/graphics board, this one by Eagle Computer certainly deserves looking into.

Requirements: Eagle PC and 1600 series; IBM PC and compatibles

Eagle Computer, Inc., \$295

ECHO SPEECH SYNTHESIZER

The Echo Speech Synthesizer from Street Electronics is a free-standing unit designed specially for the IBM PC. Its neat little box contains a Rockwell 6511 microprocessor, a crystal that generates the clock frequency for the microprocessor, a Texas Instruments speech chip, a 2KX8 CMOS

RAM that contains a buffer of approximately 1,700 characters and the EPROM, where the actual text-to-speech program resides.

Using the Echo is simplicity itself—buy it, take it home and plug it into the serial connector on your IBM PC. Its documentation has 50 of the most readable pages in the industry. The Echo has its own on/off switch and a power light that reminds you to turn it off. Every time you turn on the Echo, it responds with "Echo ready."

The Echo has many easy-to-use options. You can speed up or slow down Echo's speech. You can vary the pitch and tone to make it sing—the system has a range of nearly three octaves. An optional fixed speech software contains nearly 700 words. If you want to hear your PC talk, look into this great, low-priced package.

Street Electronics Corporation, \$29.95

EDP AC SURGE PROTECTORS

The widespread use of microprocessor chips and semiconductors in solid-state electronic equipment and computer-based equipment has amplified a problem for manufacturers and users. The problem is transient voltage surges. These surges and spikes are the principle cause of electronic and electrical equipment failures. They appear suddenly and unexpectedly. In many cases, their presence goes undetected even after component or software damage occurs. They can result in rapid component failure or a slow degradation of semiconductors that produces random erroneous intermittent signals. This can go on for weeks until total component failure occurs.

The Lemon, the Lime, the Orange and the Peach are solid-state clamping devices and EMI-RFI noise filters that use high-speed semiconductor technology and are designed to protect all mini-and micro-computers. All of the Surge Protectors work in "normal mode" (line to neutral) and "common modes" (line to ground as well as neutral to ground).

Plug any of these quality AC Surge Protectors into your electrical outlet, and then plug your equipment into it. The peace of mind is certainly worth the price.

Electronic Protection Devices, Inc., lemon \$59.95; lime \$89.50; peach \$97.50; orange \$139.95

EDUMATE LIGHT PEN

The Edumate Light Pen comes completely wired and ready to plug into the joystick port of your Commodore 64 or Vic 20. The package includes an

instruction booklet and various software programs for the Light Pen.

The software includes a high-resolution drawing program, a disk utility, a music program, and a game of Tic Tac Toe. Draw Routine lets you use the Light Pen to draw high-resolution graphics. You are offered a choice of 16 colors (in the Commodore 64 version) and options that can clear the whole screen or erase individual lines. Disk Utility is a general-purpose disk operating system that lets you use the Light Pen to select, load, and run programs. You can also initialize, validate, or format a diskette and erase files or programs. *Pen Music* lets you play music by touching the Light Pen to various dots on the screen. Twelve notes are available in each of eight octaves.

Some minor problems with the software programs are not any cause for concern; however, the *Draw Routine* has a serious restriction—you can't save your drawings on disk.

Futurehouse, \$29.95

THE ENCRYPTOR

Sooner or later all computer users realize that some, if not all, of their private records are valuable. Now there is a low-cost foolproof way to protect private files from prying eyes. The Encryptor employs the same method as Encryption Techniques, previously available only for large mainframes—a Western Digital ULSI data encryption/decryption device.

The Encryptor board is available for use with the S-100 board, Apple II and IBM PC or XT computers. It is simple to install. Each board is shipped in a configuration that is standard for the computer for which it is intended and supports the individual software package. The documentation is well done, being both clear and concise.

The Encryptor has several nice touches. When a command is entered, for instance, it is immediately cleared from the screen so that keywords cannot accidentally be left on a monitor to be viewed by unauthorized persons. The system ran error-free through all tests conducted for this review. All of its operations are simple to use.

Surely everyone can think of a very good reasons for using The Encryptor, from protecting the security of files to obtaining complete privacy for data transmissions. One word of caution—The United States Government prohibits the export of The Encryptor; do not attempt to send one to a friend outside of the United States.

Jones Futurex, \$245-\$295

EPS KEYBOARD

Executive Peripheral Systems' detachable keyboard for the Apple II and II+ computers features plug-in PROM (programmable read-only memory) modules that are used to configure it for popular software packages. When used with EPS PROMware modules, the board's 12 special function keys can provide up to 48 commands tailored for a specific software package, such as *WordStar*, *Screen Writer II*, *VisiCalc*, or *Apple Writer II*. Each module comes with a label strip that identifies the commands that have been programmed into the function keys.

The EPS Keyboard connects directly to the Apple's keyboard socket. It has a complete word processing layout with full travel key switches, multifunction edit keys, shift and shift lock keys and cursor-control keys. Most keys can automatically repeat. A built-in 21-key numeric keypad, a full ASCII character set, a parallel output and a six-foot cord are standard. The basic retail price also includes BASIC and DOS modules, as well as an interface card. Additional PROMware modules cost \$32.95 each.

The EPS Keyboard is easy to install and easier to use. Its numeric keypad makes number crunching go much faster, and its programmable function keys save a lot of time with some software. EPS is not as cheap as some Apple II replacement keyboards, but it is worth every extra penny.

Executive Peripheral Systems, Inc., \$395

EXTERNAL MONITOR ADAPTOR

With the arrival of portable computers, the big screen became smaller. Portable screens are generally 7 to 9 inches across instead of the 12 to 14 inches of most desktop models. Hours of constant staring at these small internal monitors can make users bleary-eyed. Advent Products has a quality accessory that will change all of this for Kaypro users.

The External Monitor Adaptor allows the Kaypro II or 4 to drive an external video monitor. The size or manufacturer of the monitor does not matter. Unlike most other currently available adaptors, installation of the External Monitor Adaptor requires no soldering, desoldering or wiring. In addition, installation in no way alters or damages any part of the motherboard. After removing the cover from the Kaypro, removing 1C from its socket and plugging in the adaptor and video cable are all that is required.

A special bonus comes with this package. The External Monitor Adaptor will even work with large

screen televisions that are equipped with composite input jacks. While much resolution is lost by using large screen televisions, a large monitor can be extremely useful. Training sessions and demonstrations in large rooms or aid for the visually impaired are just two applications that come to mind.

This low-cost adaptor comes complete with a warranty and a money-back guarantee. It appears to be well made, and it worked well when tested. The External Monitor Adaptor is well worth its cost, even if it is used only to make the Kaypro easier to read.

Advent Products, Inc., \$59.95

512K RAM CARD

For IBM PC and XT users who need more memory, a board manufactured by Apparat can add up to 512K of RAM to your system in 64K increments, giving you a system total of up to 640K of RAM. This 512K RAM card is one of the least expensive memory expansion boards available today. For the user who does not need a lot of extra features, this could be a good way to go.

While it would be nice to always have good documentation for installing new boards, this is often not the case in the computer add-on world. Apparat could have done a much better job of writing the manual for this card. However, the 512K RAM card is not a difficult card to install and installation instructions provided are at least adequate if not ideal.

Included with the 512K RAM card is a software package called S Drive, a utility program that allows you to use a selectable amount of memory as a fast virtual disk drive. When the system was tested with several different word processing programs, the S Drive ran error-free.

The 512K RAM card is a good way to start expanding the memory of your IBM PC or XT. For less than \$200, you can be on your way to building a 640K system. While \$200 provides you with only 64K of additional memory, it is a simple matter to add more later.

Apparat, Inc., 64K RAM (installed), \$189; 256K RAM, \$381; 384K RAM, \$509; 512K RAM, \$627

FLASH CARD

Disk emulators offer computer users advantages that no one would have thought possible a few years ago. They take computers with floppy disk drives into the speedy realm of Winchester drives. The disk emulator acts like an additional disk drive—only faster, quieter and more reliably. It saves

wear and tear on mechanical drives and diskettes. Flash Card from Syntex Systems is a disk emulator for the Apple II.

Flash Card is a plug-in, solid state board available in 147K and 294K versions. It is compatible with most DOS, CP/M and Pascal programs that are not copy-protected. A standard package from Syntex Systems includes a Flash Card board, a DOS 3.3 interface software diskette and an operations manual. CP/M and Pascal interface software diskettes are offered as an option.

The operations manual is uneven in quality and leaves much to be desired. Fortunately, Flash Card is easy to install and easy to use. Unlike its documentation, Flash Card's software is topnotch. The manufacturing quality of the board is also very good.

If you want to speed up your operations, consider Flash Card. This board, which executes your programs up to ten times faster than your Apple disk drive, may be what you are looking for, but beware: disk emulators have volatile memory. This means that if you turn off the power while the Flash Card is operating, you will lose its contents.

Syntex Systems, 144K \$395; 288K \$595

FREEDOM PLUS

Locked out. That's how many Radio Shack TRS-80 Model I and III owners have felt. For the past few years, the lion's share of serious business software has been written for the CP/M operating system. But CP/M won't run on the Models I and III. Now, a company called Freedom Technology International has developed the Freedom Plus to get TRS owners back on track.

Installation of the Freedom Plus is not easy. Nevertheless, it is within reach of anyone with an average amount of patience and manual dexterity. The manual provided will not be of much help. It is poorly written, poorly organized, and incomplete. The board itself is top-notch. The manufacturer has chosen to use industrial grade components that should assure a long life. In fact, it seems safe to say that the Freedom Plus is of higher-quality construction than the computer it plugs into. The designers deserve a round of applause for an elegant solution to a difficult engineering problem.

What about software? Will the Freedom Plus run large CP/M programs as advertised? The answer is yes, if you buy versions that work with the TRS-80's 64-column screen. (Some CP/M programs need an 80-column screen.) To its credit, Freedom Technology will configure any CP/M software for your system.

The manual is the single biggest drawback to this system. In its current state it will take hours to learn how to use it. The company does offer a 30-day money-back guarantee, so if you can't get the unit to work you can return it for a refund.

Freedom Technology International, price not available

GAME PORT III

The Apple III is a high-powered, sophisticated computer, but you can't use it to play Space Raiders or, for that matter, any Apple II games that require a joystick or paddles. The Apple III was designed to use more than 64K bytes of RAM and this design did away with the permanent memory location used by the Apple II paddles. Although the new joystick input designed for the Apple III uses a much better analog-to-digital converter than the Apple II, this is not much help. Almost all Apple II games were written to use the Apple II joysticks or paddles.

The opportunistic people at Micro-Sci Corporation have filled this gap with the Gameport III. This short card slips into any slot on the Apple III motherboard. Once the hardware is installed, the Apple II emulation disk supplied with the Apple III must be modified to handle the Gameport III. Micro-Sci provides a disk that makes this a one-step chore. The user boots the disk, which will then ask for the Apple II emulation disk and will modify it automatically. The Gameport ran all of the software tested and did it in good fashion. However, two problems do present themselves. One is that the Gameport will only display in color on an Electrohome RGB monitor. All other monitors will only display in black and white. The second problem is that each time the user wants to run a new game or use the computer in the normal Apple II emulation mode, the system must be rebooted, a most annoying and time-consuming procedure.

Micro-Sci Corp., \$74.95

THE GUARDIAN ANGEL RESERVE POWER SUPPLY

The Guardian Angel in-line reserve power supply provides backup power for up to 150 watts of connected equipment. It's conservatively rated at 2 to 6 minutes of power for a full 150-watt load or 15 minutes for a 75-watt half load, which makes it a lightweight among reserve supplies. Time can be extended to 6 to 12 hours with external batteries, though the extra cost may be excessive.

Short holdup time means that orderly equipment

shutdown should start immediately when a power failure occurs—Guardian Angel does not afford the luxury of waiting out a failure. Recharging from a deep discharge takes about 12 hours.

Like other standby supplies, there is switchover time between power failure detection and battery takeover, usually less than 10 milliseconds. Such switching occurs within the tolerances of small systems like the Apple II+ or COMPAQ.

Output is a rectangular waveform that can slow cooling fans, AC-driven disk drives, and other motors. It also degrades the images on video monitors, causing dimming, rippling, and instability. Still, it works acceptably on small systems with DC-driven disk drives and adequate cooling provisions.

Guardian Angel tends to switch rapidly, or “ratchet,” if returning input power is unstable, and the unit lacks a provision to delay switching back to line from battery when power is reapplied.

R.H. Electronics, Inc., \$595

HERCULES GRAPHICS CARD

Do you want to add graphics to your IBM PC or XT? The Hercules Graphics card from Hercules Computer Technology will do this and more; however, this card will not drive a color monitor.

Installation is as simple as pulling out the IBM monochrome board and replacing it with the Hercules Graphics board. A spare card guide is provided and the installation instructions are easy to understand. The card features printer port which allows you to replace the IBM monochrome board and preserve an expansion slot.

The Hercules Graphics board provides a 720 by 348 point display as well as the standard IBM 80 by 25 character text display. Testing the character display showed that the text is as crisp and clear as the IBM display.

Testing the graphics display proved to be difficult. While the installation instructions had been easy to understand, the operating documentation and software manuals are inconsistent and vague. Once the graphics system is running, though, it is easy to work with. It offers, among other things, two graphics pages for limited animation.

The only real problem encountered during testing was an occasional failure to boot on power up. The solution to this seems to be turning off the power switch for a minute or so and then turning it back on. This and the poorly written documentation are the major flaws of the Hercules board.

Hercules Computer Technology, \$499

HERO

Hero is short for Heath Education Robot, a 20-inch robot that is lots of fun to have around the house. Built into the Hero is a Motorola 6808 CPU along with 4K bytes of RAM, and 8K bytes of ROM. Both RAM and ROM are expandable. It has a bus port that allows you to experiment and hook additional peripherals up to the unit. Hero also incorporates an ultrasonic sensor that allows it to detect movement or calculate distances. One routine Hero does quite well is the detection of intruders. Point its movable head at a door or a window and it will detect the presence of an adult as much as fifteen feet away.

Unique to Hero are its voice-synthesis and voice-recognition capabilities. The voice synthesizer built into Hero is based on the familiar Voray SC-01 chip, which can create 64 different vocal sounds. A four-step pitch control that helps create more human-like inflection is standard on the SC-01. The voice input circuitry of Hero converts the incoming sound to 8-bit digital words for processing.

Hero really takes a lot of work before it becomes fun. It does not have sensors to help it move around inanimate objects. To make Hero go anywhere, you must program its movements step by step into a keyboard on its head. You can also “quick teach” Hero by using what Heath calls a remote teaching pendant, actually an overgrown joystick that attaches to the robot through an 8-foot-long cable. With the pendant, you can access all of the right stopper motors that control Hero’s body and arm movement. For the price, a little updating is called for.

Heath Company, \$2,500

HJL-57 KEYBOARD

HJL has tried to put every popular feature they could into their HJL-57 Keyboard. It looks like they’ve done a nice job of it.

Like other premium replacement keyboards, the HJL-57 is a full-travel, professional-style unit with four function keys. All the keys are sculpted for good “feel.” It is also shielded to cut down on interference with the TV screen, a feature found on no other replacement keyboard.

Installation is simple enough for anyone, and it requires no gluing, soldering, or modifying of the computer’s case. The HJL-57’s switch contacts are rated for 100 million cycles, and it comes with a one-year warranty. HJL provides sample software for the function keys to perform tasks such as a screen dump, lower/uppcase switching, and key

repeat. There is no extra charge for the function-key software.

The HJL-57 is at the top of the price range for Color Computer replacement keyboards, but the user will find no better quality.

Compatibility: TRS-80 Color Computer
HJL Products, \$79.95

HMS 3264 EPROM PROGRAMMER

The HMS 3264 EPROM (erasable programmable read-only memory) Programmer package allows the Apple II computer to handle a broad range of software development tasks. The package consists of a circuit board, a DOS 3.3 disk that has the software necessary for programming Intel-compatible EPROMs and full documentation.

The Programmer Board can be installed in any Apple II expansion slot from 1 through 7. To allow easy removal of EPROMs without having to remove the board, an empty slot should be left on either side of the board. Mounted on the HMS 3264 card are three gold-plated sockets. Each socket is marked to indicate the type of EPROM device(s) it is designed to hold (2716, 2732, 2732A, and 27128).

The HMS 3264 requires an Apple II with at least 48K of user memory, *Applesoft BASIC* and an Apple II disk drive and controller. It is intended for Apple II owners who use their computers as development systems, manufacturers of controllers who need a production EPROM programmer and hobbyists who write their own programs.

The operations manual packs a lot of information into 25 pages. Its layout and style are good, but it could be a little more extensive. The software supplied is very good. It is menu-driven and the user prompts that it generates make its operation fool-proof.

The HMS 3264 is not for the novice. It is a sophisticated product that requires some computer experience.

Hollister Microsystems, Inc., \$395

H-1000

The H-1000 is a plug-in replacement CPU for the Heath-Zenith (H89/289) Personal Computer. Its Z-80 microprocessor has twice the speed, twice the memory, and twice the I/O capacity of the original board. Its 16-bit 8086 microprocessor has ten times the speed of the Heath/Zenith original.

The H-1000 comes with 256K of RAM, expandable to one megabyte. The 8086 microprocessor can address this full address space directly, but a Z-80 can ordinarily address no more than 64K. To make the additional memory available to the Z-80, special

paging hardware is included on the H-1000 to establish up to 16 independent banks of 64K each.

The Z-80's clock speed is software-selectable. At 2 MHz it will run all of your Heath/Zenith programs; at 4MHz it will run most of those programs twice as fast.

The 8086 microprocessor gives the user access to the ever-expanding pool of software written for the IBM PC. It will run that software twice as fast as an IBM PC because its 8 MHz clock speed is almost twice as fast as the IBM 8088 clock speed and because the 8086 microprocessor uses a full 16-bit bus. The H-1000 will not run all IBM PC software—users should try before they buy.

Technical Micro Systems did a wonderful job designing this board. It is well-constructed and very well-documented. Still, potential users should consider whether or not it is wise to buy a replacement board at a price that could well provide a new computer.

Technical Micro Systems, Inc., 128K RAM \$995; 256K RAM \$1,245; 512K RAM \$2,240; 1 megabyte \$34.90

IBM GAME ADAPTER CARD

The IBM Game Adapter is a plug-in card that is considerably shorter than a standard IBM expansion card. It fits into any expansion slot on the motherboard, but IBM recommends installing it in slot 1, 2 or 4. Slot 1 would be a good choice, because a longer board installed there would muffle the IBM PC's internal speaker.

The Game Adapter accepts four resistive inputs and four digital inputs, which are attached through a female 15-pin D shell connector that extends through the back panel of the IBM PC. The resistive inputs are attached to joystick handles, and the digital inputs are general joystick buttons. Up to two joysticks, each with two buttons, can be attached to the game adapter.

IBM has done its usual good job of providing informative documentation that is easy to read and to use. The Game Adapter Card is well-made, and, as it was designed by IBM for IBM, it has no compatibility problems. Even so, why buy a Game Adapter Card when PC expansion slots are so limited and the functional equivalent of this card is a part of most multifunction boards?

IBM, \$45

IDEAPLUS COMBINATION CARD

The IDEApplus Combination Card adds 64K to 256K of memory and up to three functions or options to an IBM PC, IBM XT or IBM-compatible sys-

tem. This full-size card can be installed in any available expansion slot. Up to three of the following four options may be chosen: parallel printer interface (may be assigned to LPT1, LPT2 or LPT3), RS-232C serial interface (may be assigned to COM1 or COM2), disk interface or battery supported clock/calendar. Memory locations are assigned with onboard switches and internal computer switches that set the starting address for the board and the total memory available.

The software that accompanies IDEApus includes a memory diagnostic, the optional clock/calendar, *RAMfloppy*, a printer spooler and a printer swapping program. This software works only with PC-DOS. Users of IBM-compatible computers must purchase PC-DOS in order to use these programs.

The *RAMfloppy* program can use all available memory on the IDEApus card, the main computer board and other memory expansion cards to set up one 32K to 320K high-speed "memory disk." In this manner, *RAMfloppy* allows the system to function as if it were equipped with one more disk drive than is physically installed.

The printer spooling software establishes a 4K to 64K print buffer. This allows 2 to 26 pages of text to be spooled to the printer while the computer is free to do other tasks. If sufficient memory is available, the memory disk option and the spooler may be used at the same time.

IDE Associates, Inc., \$329 to \$529 for 64K to 256K with one option; \$359 to \$569 with two options; \$389 to \$599 with three options

THE INTERCONNECT SET

The Interconnect Set from SYZGY consists of a PC board with an RS232 female connector on one end and a male connector on the other. All 25 RS232 signals are passed to a header block near each end of the board. By the use of jumpers or a wire-wrap technique, complete configuration of the interface can be quickly accomplished. The protective ground and the signal ground are passed through by the circuit board and need not be jumpered.

One can connect a non-terminated RS232 round cable directly to the board via a nylon tie and a row of holes in the PC board to which the individual conductors can be soldered. There are ten such holes for soldering and they include both protective ground and signal ground. The remaining eight are connected to a central configuration of either or both ends. This permits a cable to be terminated with a male and a female connector. Alternatively, the cable can be used for establishing

secure connections for monitoring equipment which can be used at a more convenient distance while the unit remains in line with the desired configuration.

The unit is a black molded case with a mylar-coated label that gives the pin number, signal name, function, EIA and CCITT circuit technology for the RS232 signals. Locking hardware of either persuasion can be used and one pair of each gender is included. Along with one nylon tie wrap, The Interconnect Set is supplied with one 5-pin, two 3-pin, and five 2-pin jumpers. Until the computer industry learns the meaning of compatibility, this is as good as you are going to get.

SYZGY, \$47.50

INTERFAZER

Print buffers have been around for some time and have proved themselves useful additions to computer systems. In the normal course of events, one sits and waits for the printer to finish before being able to resume computer use. Buffers allow use of the computer while the printer is working. Quadram's Interfazer can buffer up to 128,000 characters of data and can direct the printing jobs of up to eight computers.

The Interfazer is a stand-alone unit that allows you to use two printers in a network without making mechanical changes. It stores data and then feeds it to one printer at a time at the printer's own speed. The printer can be parallel or serial, and the computer's baud rate does not need to match the output device's baud rate. The Interfazer is controlled by its own 8085 microprocessor and contains eight slots for input devices and two for output. LEDs on the front panel indicate activity status and display error messages. The Interfazer operates on a priority port system (first data in is the first data out) and also functions as an incompatible device interface, computer I/O expander, data transfer rate converter, and additional peripheral buffer.

Computerized offices can now share expensive peripherals among many users and can do computing and printing at the same time. This is truly an intelligent system that brings down the costs of operations for groups of users and helps to bring order to the interactions of their systems.

Quadram Corporation, \$295 and up

IS PIPELINE RANDOM ACCESS PRINTING BUFFER

The IS Pipeline is a printing buffer that can be equipped with 8K to 128K of storage, with provision

for user installation of memory chips to enlarge small buffers.

Unlike printing buffers that simply accept computer outputs, store them, and transmit them to the printer in strictly sequential order, the IS Pipeline has three operational modes. First, it can operate as a single sequential buffer. Second, it can be bypassed so the computer remains in direct control of the printer at all times. Third, and most intriguing, it can be used in randomly accessed segments.

Up to 63 independent "buckets" of varying sizes may be set up, filled with data, and printed in any sequence desired—all under software control. Print some buckets or all buckets once or several times in succession. Do "cut and paste" or "boiler-plated" documents with the buffer instead of tying up the computer to assemble the pieces for each printing pass. Random access buffering like this can greatly improve the productivity of word processing and other computerized tasks.

Software commands are simple, easily learned, and easily applied. They can be issued from word processors or user programs just like any printer control commands.

The current configuration has parallel Centronics-compatible input and output ports (one each), but a future unit will have two serial and two parallel ports.

Interactive Structures, \$195 8K; \$440 128K

ITS-PC

As more and more IBM PCs are integrated into the business world, it becomes more important for these computers to be capable of communicating with mainframes. Alloy Computer Products has come up with one solution with its ITS-PC board.

ITS-PC is an intelligent drive which allows users to freely transfer data between their personal computers and nine-track tape, hence between IBM PCs and mainframes. It is available with an integrated cipher tape drive that provides users with high capacity, high speed, and file-oriented backup for Winchester drives. ITS-PC offers 42 MB of working or backup storage and a disk-tape transfer rate of 1 MB per minute, supporting 1,600 BPI tapes with user specified formats from 128K bytes to 9KB per block.

The nine-track board comes with PC-TIP software. The TIP package supports the nine-track board and the tape drive, providing controls for reading, writing and dumping operations. TIP also provides utilities which enable the user to customize his own driver operations.

The documentation is clear, though somewhat

technical, and provides precise installation and operating instructions. The ITS-PC worked the first time and every time thereafter. The PC-TIP software package was error free in its operation. Alloy Computer Products not only provides a full warranty, but fully supports its product with a telephone hotline.

Alloy Computer Products, \$6,995

JOY SENSOR

The Joy Sensor is described by the manufacturer as a "touch-sensitive joystick simulator." Looking more like a remote control for a TV set, the Sensor measures 6.5 by 3 inches and has two touch-sensitive surfaces, one each at the top and bottom of the unit. The surface at the bottom is a circle 1.75 inches in diameter. It has eight directions marked on it corresponding to the eight ways a joystick may be moved. For maze type and other games requiring movement in just four directions, a slide switch in the center may be moved to the left to lock out the diagonal directions. A rectangular surface at the top has two standard firing controls at each side and a rapid fire sensor in the center.

Suncom recommends holding the Joy Sensor in one hand and using the opposite thumb to control direction on the touch panel. Firing is controlled by the thumb of the hand holding the unit. Suncom warns that "it may take a while for you to learn how to best use your Joy Sensor, but once you do, you won't want to stop." Well, maybe. The Joy Sensor is difficult to get used to. And scores for most games suffer badly. The best feature is the rapid fire button which assures long survival in games like Defender; holding the button down makes you practically invulnerable. Now if only you could maneuver, too.

Suncom, price not available

JRAM-2

The JRAM-2 from Tall Tree Systems features up to 512K of RAM on a single board. It is a standard-size circuit board that fits in any IBM CP expansion slot. Options available for JRAM-2 are an RS-232 serial port, a parallel port, and a clock/calendar. Included in the standard package are *JETDRIVE* and *JSPPOOL*, two software programs. *JETDRIVE* is a disk emulator, and *JSPPOOL* is a device-driver/print-spooler that is compatible with both parallel and serial ports.

All of the memory on the JRAM-2 is invisible to DOS and its application programs. It can only be used by Tall Tree software. This means that the

memory is reserved for use by the JETDRIVE disk emulator and the JSPOOL print spooler. For this reason, JRAM-2 might not be the first memory expansion board a user would choose to buy.

The software and instruction manual that accompanies JRAM-2 is overly technical and has too few examples. Also, the Tall Tree software programs have obvious bugs. Although they recommend some patches that should help you to eliminate these bugs, business ethics should have mandated a fix before the software was released. Let's hope that an update will be forthcoming, free of charge. Problems aside, this is a useful product that has plenty of power and the flexibility to accommodate even the largest of programs.

Tall Tree Systems, 0K RAM \$219; 512K RAM \$619

KB 5150

There is nothing wrong with the IBM Personal Computer keyboard, you say. Sure, it's a little strange, but it has a nice feel to it, you say. You get used to stretching your fingers to infinity after a while, you say. Well, just wait until you wrap your fingers around the KB 5150 keyboard from KeyTronic. The KB 5150 asks you to get used to nothing. The smart designers at KeyTronic moved Shift and Return (that's right, no more symbols, just words) back to where they belong, and that move alone earns them the "brass ring." Then they cut that large "plus" key on the keypad in half and made the bottom half an "Enter" key. Great! Then in an absolute stroke of genius, they gave us LEDs on the Caps Lock and Num Lock. How many times have you wished for those?

The KB 5150 keyboard has a totally different feel from the IBM original equipment keyboard. It's much lighter to the touch and the keys in the middle are flatter. The KeyTronic people would call them ergonomic. Believe it, when you quit hitting the slash key when you mean to hit the shift key and you reeducate your fingers to this no-torture situation, you're going to be typing a whole lot faster. This solid, well-constructed keyboard is what touch typists have been waiting for. Try it, buy it, and get back to speed again.

KeyTronic, \$235

KEYBOARD-2

The Keyboard-2 is billed as a professional word-processing replacement keyboard for the IBM PC. All of the IBM keys are included, but they have been redistributed to shorten the overall length of the board to 15 inches. This is four inches shorter than

the IBM keyboard. The Keyboard has thin walls and a die-cast magnesium frame. It appears to be rugged, yet it is lighter than the plastic-cased IBM board.

The major changes in the key layout concern the function keys and the cursor control keys. The function keys have been moved from the left side of the keyboard and repositioned along the top. An additional set of cursor control keys have been added to the top of the left-hand side. This set of keys can be used without the NUMS LOCK key. LEDs have been added to the CAPS LOCK and the NUMS LOCK keys.

Moving the function keys to the top of the board makes them easier to use and makes the keyboard much shorter. The second set of cursor keys appears to be a gimmick. They are awkwardly positioned and very difficult to use. Also, the rim around three sides of the board gives it a closed-in, cramped feeling. Even if it does not get in the way, the user will probably feel that it does.

Colby Computer, \$260

KEYWIZ

Sometimes even the best programs seem to require too many keystrokes. It gets just plain boring, entering line after line of commands. Somehow, the complicated commands and repetitive tasks get in the way of what you want to do. Then the tedium and complexity make you more prone to error. Now the Keywiz from Creative Computer Peripherals, Inc., takes some of the unpleasantness out of using your Apple computer.

Keywiz is a user-definable keyboard featuring 31 keys which can be shifted and unshifted for a total of 62 keys. The memory of the unit can store up to four different keyboard configurations at one time. Unlike other keyboards, Keywiz is complete. You don't have to buy extra PROMs for different applications. With one unit, you could have Apple Writer, VisiCalc, and Pascal keyboards available at one time.

Installation is tricky, involving disassembly of the case from the motherboard. However, once installed, you can forget about it. Keywiz does not have to be disconnected when not in use, and it will not bomb any program. The documentation consists of an installation guide and an instruction booklet. Keywiz is also supplied with blank templates to be placed over the keyboard. While the instruction booklet is complete, the installation guide leaves a great deal to be desired. More than both sides of one page are needed for such a complex operation. Also, Creative Computer Peripher-

als never tells you that installation of Keywiz could void your Apple warranty, which it does.

Creative Computer Peripherals, Inc., \$299

KOALAPAD

The KoalaPad is a touch-sensitive input device for personal computers. Its manufacturer calls it a touch tablet to emphasize the range of its applications beyond its use as a graphics tablet or video drawing board, although the latter is what most people will probably use it for.

This is the first reasonably priced accessory useful for drawing directly to a video screen. The main reason behind its economy is the KoalaPad's rather small size. It measures about 6 1/2 by 8 inches, but the actual surface of the pad is just a little over 4 inches square. This may seem small, but it is really quite useful, and your hand will adapt easily to these dimensions.

Two large bar switches are located at the top of the tablet and are used for signalling changes in program functions. The KoalaPad is comfortable to hold and to use—it just feels good in your hand or on your lap.

Technically, to the personal computer that you're using the KoalaPad looks like a pair of game paddles. So it is very simple to incorporate the pad into programs that you write yourself.

Included with the KoalaPad is an excellent drawing and painting program. Different versions called *The Illustrator* or *Koala Painter*, work with different kinds of computers. The two programs are almost identical. Both allow you to draw lines, boxes, and circles with different brushes of varying widths and textures. You can also paint and fill in with solid colors or multicolor patterns and save your pictures on a floppy disk. The software also has a number of other useful graphic utilities.

Koala's painting programs are not simple demonstrations, but excellent examples of what can be done with the pad. Koala plans to offer other programs—from children's games to business software—that take advantage of its hardware, but even these graphic programs alone make KoalaPad a very useful accessory.

In all, this is a sturdy, nicely-designed accessory. Considering the quality of the included software, it seems to be an excellent buy.

Koala Technologies, Apple, 48K RAM \$125; Atari, 48K RAM \$100; Commodore 64, \$100; IBM PC, 64K RAM \$150

THE KRESS EXPANSION

The KRESS Expansion unit is a six-layer, glass-epoxy board that plugs into the CPU card of a H/Z-89 Personal Computer. This Expansion unit is not a stand-alone, but actually goes inside the H/Z-89 case. It gives the user a total of seven right-hand slots: Three are approximately where the right-hand connectors are now, plus four additional slots placed horizontally.

Simply connecting more slots in parallel with those already existing would be of marginal use. For example, each function added to the bus often takes one complete block, and the two spare slots on the H/Z-89 share only four I/O blocks. Plug in a three port serial board and a floppy disk controller, and all the ports are in use. The KRESS Expansion solves this problem by letting the user select the port decoding needed.

KRESS Shadow Operation is a software program that is included in the price of the Expansion unit. It was written to eliminate conflicts between enabled and disabled boards and it works very well.

The KRESS Expansion is a very workable solution to the limited expansion slots offered on the original H/Z-89.

KRESS Engineering, \$395

LA-200

Total Logic Corporation's LA-200 provides the necessary hardware and software for transforming an IBM PC or IBM XT into a logic analyzer. The system's hardware is made up of a standard-size expansion plug-in card, test cables, and a color-coded probe pod.

The system's data path is 32 bits wide, and the memory depth is 1,024 data words. When it is used with the IBM's clock, the LA-200 operates synchronously or asynchronously at rates up to 15 MHz. Six hardware clock qualifiers allow flexibility in selecting data points of interest in complex multiplexing applications. A sequential trigger mechanism lets you choose a variety of options, including up to eight sequential triggers for starting or ending a data trace. Multiple start/stop conditions can be created by using triggers. Captured data can be displayed in a variety of formats, including timing diagrams and binary, hexadecimal, octal, and ASCII codes.

The LA-200 software gives the user a menu from which to choose analyzer functions. Functions include setup, data collection, display, and printing, data comparisons, and a data- and setup-parameters storage function. Full-screen editing and setup defaults are standard.

Obviously, this peripheral is intended for the professional computer user, but even professionals will have a hard time getting started because of the poorly written manual. Documentation for a board of this complexity should be better prepared and organized in a more readable manner. The LA-200 has a minimum system requirement of an IBM PC or IBM XT with 64K bytes of RAM and a single disk drive.

Total Logic Corporation, \$1,950

LABMASTER

Tecmar's Labmaster is an interface for the IBM PC or XT that converts digital data to analog and analog data to digital (D/A and A/D). In addition, the Labmaster provides counting, timing, and digital input/output features.

The Labmaster was designed for scientific applications. It consists of a full-size motherboard that is plugged into one of the PC's expansion slots as well as a daughterboard in a metal box that sits outside the PC. The two boards are connected by a 50-conductor ribbon cable. A/D conversions are performed on the daughterboard while all other functions are handled on the motherboard. Packed into the boards are sixteen single or eight differential A/D channels, two D/A channels, five to sixteen bit timers/counters and twenty-four digital input/output lines. A number of extra options are available at extra cost.

The installation and instruction manual fits into an IBM binder. Generally speaking, the manual is clear and complete; however, because of the Labmaster's intended use, the manual is somewhat technical in nature. The software package for the Labmaster, LABPAC, was not available at the time of this review.

Tecmar's Labmaster board provides a powerful, flexible D/A interface for the IBM PC. At present, it can only be used by someone with appropriate programming skills. As soon as LABPAC arrives on the scene, it will be considerably easier for the less skilled to use this sophisticated interface.

Tecmar, \$995

LIGHT PEN AND FLEXIDRAW SOFTWARE

Inkwell Systems' Light Pen is designed for the Commodore 64. Don't mistake this for another toy pen. This is a high-quality pen made by a company that also manufactures pens for industrial and medical applications.

This pen is heavier and a bit bulkier than most. It

is packaged in a sturdy black plastic case. All of its electronics are built into the barrel, which accounts for its size. Although large, it is not uncomfortable in your hand, and the size may actually be an advantage for children who use it. The pen attaches to the Commodore 64's control port 1 by means of a thin cable approximately three feet long. The switch that activates the light pen—which actually tells the computer to read the location you are pointing at on the screen. This switch is spring-loaded and built into the tip of the pen—a very nice feature.

Unlike most pens, this one can claim resolution down to a single pixel on the video screen. This is well demonstrated with *Flexidraw*, the software that comes packaged with the light pen. *Flexidraw*, part of a series called *Penware*, is more than just a demonstration program; it forms half of the Inkwell system. It is a very powerful graphics system that creates images that can be printed on paper with a dot-matrix printer. The program can switch between two different memory areas, transfer pictures (or parts of pictures) between these areas and shade the drawings with several different patterns. *Flexidraw* is about as easy to use as the Micro-Illustrator or the paint program that comes with the KoalaPad. However, *Flexidraw* does not yet support color graphics and uses only the leftmost two-thirds of the Commodore 64's full video screen image.

Other programs included with *Flexidraw* are *Flexiplot* (graphics routines that can be used with your own BASIC programs), a pen-based sprite editor, and two simple sound demonstration programs. You'll also find two sets of symbol templates for use with *Flexidraw*, one with architectural symbols, the other with elements of electronics schematics.

Inkwell has also previewed an excellent extension of *Flexidraw*, a separate program that allows fast graphic communication between two Commodore 64s linked via modems.

Inkwell Systems, \$150

THE LITTLE BOARD

AMPRO Computer's The Little Board will help hobbyists who want to build their own computers. The Board is a complete, miniature, single-board CP/M-based computer that is compatible with 5¼-inch floppy disk drives.

The Little Board contains a Z-80A central processing unit that runs at 4 MHz, 64K of RAM, a 2732 boot EPROM, an on-board 12-volt DC power supply, a terminal port, a modem port, a printer port,

and a floppy disk drive controller. AMPRO also provides the CP/M operating system and a set of utility programs. The board can be mounted directly onto the bottom of almost any 5¼-inch floppy drive by using the drive's four threaded holes.

This board is big in its functions but small in its space and power requirements. It occupies only 45 square inches and consumes less than 5 watts of power.

AMPRO Computers, \$349

MAGELLAN LIGHT PEN SYSTEM

The Light Pen System from Magellan Computer was designed for the Apple II+ and IIe computers. Unlike models that plug into one of the expansion slots on the Apple motherboard, the Magellan Light Pen is connected to a miniature electronic module that attaches to the computer's game port. Its design allows game paddles, joysticks, and other accessories to share the game port with it.

Included with the system are the *Quick-Draw* and *Amber-Pen* software programs. *Quick-Draw* allows the user to easily create and edit commercial-quality graphics designs. *Amber-Pen* allows programmers to incorporate the Light Pen into Apple BASIC programs.

The Pen's high resolution allows single-dot editing on the Apple's display screen. Its builtin push-button gives the user maximum control over drawing and eliminates the need for distracting interaction with the keyboard.

The instruction manual that comes with the Light Pen leaves much to be desired. While this is not an expensive system (as computer products go), Magellan Computer could have done a much better job with its documentation.

Magellan Computer, \$189.95

MAGSTIK

Most joysticks are either self-centering or non-self-centering. The few joysticks on the market that allow self-centering to be defeated do so by means of a mechanical arrangement that involves either unhooking some springs manually or adjusting small levers in the base of the control housing. Tech Designs, Inc. has a better idea, a new joystick called Magstik. It has been designed especially for Apple users.

The Magstik has a magnet attached to the bottom part of the joystick and a second magnet in the bottom of the housing. When both magnets are in place, the joystick is self-centering. However, when the module containing the housing magnet is removed, the joystick is free-moving. No springs, no

levers, no switches to foul up. The feel of the Magstik in the non-self-centering mode is amazingly smooth and responsive. But the same is true of the self-centering mode. Gone is the "clunk" as the springs tug the stick back to the centering position. Moreover, the Magstik has a centering adjustment on each direction of the stick which permits the user to fine-tune the stick to whatever game he is playing.

The two firing buttons are on the upper left side of the housing. This may be the only poor choice Tech Designs made. It is very difficult to get two fingers on them simultaneously. Nevertheless, the Magstik is one of the best Apple joysticks around. It is easily worth the relatively high price.

Tech Designs, Inc., \$64.95

MASTERGRAPHICS ADAPTER

The MasterGraphics Adapter board from MicroGraphics Technology combines the two functions provided by the IBM Monochrome Display Adapter on a single board. It also offers various enhancements and such special features as more display memory, 16 colors in high-resolution graphics and graphics on the IBM Monochrome Display.

The MasterGraphics board has a single Motorola 6845 CRT controller chip, dual timing and control logic, and display buffer RAM that is shared by the display logic and the 8088 CPU on the IBM motherboard. It offers 32K expandable to 128K RAM, much more than the 4K to 16K on the IBM Monochrome and Color Adapters. This extra memory can be used to store additional screens in the standard IBM mode and provides the required space for the higher-resolution extended color modes.

MasterGraphics allows a color and monochrome adapter to be connected to the board at the same time. They cannot be active simultaneously, but control can easily be switched from one to the other with software that is provided.

The documentation is overwhelming. There is so much of it that it cannot be assimilated at one sitting. Nothing is left out or left to chance. The board itself is well-constructed and fits in a standard IBM expansion slot. Both board and software work well, without any obvious problems.

MicroGraphics Technology, \$579

MAYDAY 60+6S RESERVE POWER SUPPLY

The Mayday 60+6S provides 600 watts of standby power for computers, peripherals, or other electronics during power outages. An optional

sine-wave output makes this unit particularly attractive for equipment that won't tolerate rectangular waveforms.

As an in-line unit, the Mayday can power several pieces of equipment simultaneously, and it has provided just over a half hour of running time on a system load estimated at 350 watts. Recovery from a deep discharge can take as long as 12 hours.

This switching power supply goes to battery when AC line power fails and during voltage fluctuations or surges. However, switchover seems slow for critical equipment and may blank or disrupt a CRT screen even though the computer continues to operate.

Unlike many other units, Mayday does not use internal batteries. It operates from two external 12-volt wet cells that require maintenance and careful handling. Users do have to handle electrolyte (sulfuric acid) and cope with electrical arcing when installing the unit. Other batteries are extra-cost options. The unit is heavy and bulky, making it difficult to handle. It's also noisy when operating, which may be bothersome in an office environment.

Despite shortcomings, the Mayday 60+6S gets the job done and may, in certain cases, be the only affordable unit capable of powering certain types of equipment.

Sun Research, Inc., \$1,140

MBP AND MBS EPSON INTERFACE SERIES

An Epson printer prints 80 characters per second. At this speed, it takes about five minutes to print a 16,000-character document. During most of this time, the computer without a print buffer is waiting for the Epson to finish one line so that it can send the next. Using a print buffer, the computer will take only four seconds to send a 16,000-character document.

Each board in the MBP and MBS Epson Interface Series of boards from Practical Peripherals plugs into the auxiliary interface connection inside the Epson without modification to the printer. You can choose between two models, both of which are compatible with the Epson MX and FX series of printers. The MBS is an intelligent RS-232C serial interface, and the MBP is an intelligent Centronics-compatible parallel interface. Both are available with up to 64K RAM, and both are compatible with all standard Epson commands and GRAFTRAX-80. In addition, the serial version also supports XON-XOFF software and hardware. Because this interface doesn't require any user software for control, it's ready to go as soon as you plug it in. In tests

using an IBM PC and an Epson MX-100, it performed flawlessly, speeding up the workflow while providing error-free printing.

Practical Peripherals offers a five-year warranty for parts and labor, so you know it thinks a lot of this product. This is a very productive add-on that will help you to get the most out of your computer.

Practical Peripherals, \$159 to \$279

MC 1 MUSIC CARD

The MC 1 Music Card from ALF Products allows your Apple II to enter the exciting world of computer-controlled music at an affordable price. The Music Card package includes a circuit card, a stereo audio output cable, an owner's manual and software on disks. You get entry, play, perform, disco, and seven sample songs that are compatible with both *Integer BASIC* and *Applesoft BASIC*. Installation is as easy as plugging the Music Card into any available Apple expansion slot. When you boot a disk, a start-up program automatically configures the software to work with the expansion slot you have selected. The package's audio cable attaches to the Music Card and plugs into your home stereo system. You can have the system playing a sample song in minutes.

The MC 1 has nine independent voices: three for the left output, three for the right, and three for both. One voice from each stereo position can be used in either "normal mode" for tonal notes or in "fuzz mode" for such special effects as percussive sounds. The system's nine independent pitch generators use a wide range of frequencies for a variety of musical constructions.

When a song is played back, the Apple screen shows its title, composer and conductor. Above this text, an interesting color display of the music appears as it plays. The pitch of each voice is shown by the relation of a moving dot to a line that marks middle C. The color of each dot indicates its current volume. Altogether, this is a complete system for the musically inclined.

ALF Products, Inc., \$195

MC 100 MOTOR CONTROLLER

The MC 100 Motor Controller system consists of an S-100 controller card, a manual control panel, and the CP/M driver software. Of the many options available to the system designer for controlling digital motors, the MC 100 is the only one designed specifically for S-100 computers. This feature allows for a reduction of the total system cost because the motor control function is integrated

within the computer chassis and does not require a separate stand-alone unit.

The MC 100 will directly drive two moderate-power four phase motors. Snow Micro Systems also offers an optional universal translator interface that allows higher-power motors to be controlled by the system. Other significant features of the system include motor ramping, automatic limit sensing, and internal or external step pulse-count functions.

One of the newer S-100 boards around, the MC 100 Motor Controller card is fully compliant with the IEEE 696 standard for interface with the S-100 bus. It is a well-constructed 5 x 10-inch card that appears free of any shoddy workmanship. The manual control panel measures 6 x 4 inches and is manufactured to the same standards as the MC 100 card. Its function is to give the user control of motor step and variable jog rates in either direction. The CP/M compatible software package that accompanies the MC 100 allows for complete control of all system features with a simple software interface which may be accessed from BASIC, FORTRAN, or assembler language programs. All told, this is a most useful product at a price that is affordable.

Snow Micro Systems, \$445

M-DRIVE/H

CompuPro's M-Drive/H was not really the first RAM board dedicated for use as a disk emulator, merely the first to be widely distributed in the United States. It remains one of the best available for the S-100 bus.

If you've never used a "RAM disk," you may well wonder what all the fuss is about. So imagine a long session of programming: You write the program with your editor, exit to your operating system, and call up the compiler. When it finds bugs in your code, you call up the editor again and repeat the process. Then comes the linker, perhaps with its own set of newly revealed bugs. All these operations require slow, tedious disk accesses that can add hours to the development of even a relatively simple program. But not with a disk emulator. Moving data to and from RAM is a good 50 times faster than shifting it between a disk and working memory, so those delays vanish.

Nor are programmers the only ones to benefit from RAM disks. Using *dBASE II* with CompuPro's very fast 8-inch drives, it takes nearly 11 minutes to create an index on two keys for a database of 750 records each about 150 bytes long. With the M-Drive/H, it takes less than three minutes.

An odd and revealing test came up in sending *WordStar* files by modem. Unless a binary transfer is used, the process creates a hard carriage return after each line. The obvious answer is to write a filter program to remove them, but circumstances prevented this. Stripping them out with *WordStar*'s search and replace function turned out to be even slower than retyping the file. As the returns disappear, *WordStar* treats the text as a single line, and its file handling slows dramatically. Used with 5¼-inch drives to strip returns from a 7½-page document, about 20,000 characters, *WordStar* slogged its way through the last page at a rate of less than one line per minute. The file took four hours to complete. With the CompuPro and M-Drive/H, the process was over in 40 minutes. This is a good worst-case demonstration of the disk emulator's powers.

The M-Drive/H supplies 512K of pseudo-disk space per board, and up to eight boards may be used in a computer system. It will accept non-CompuPro I/O and RAM boards, but the CPU and disk controller must be theirs. In practice, for anyone who is not up to writing his own CP/M BIOS this probably limits it to CompuPro computers. The M-Drive/H is not such a wondrous item that it justifies throwing out the computer you now own in order to get a machine that will use it. But for those already lucky enough to own this well-respected equipment, it is an accessory well worth having.

Compatibility: Any S-100 system with a CompuPro CPU and Disk 1 controller
CompuPro, \$1,745

MEGAPLUS BOARD

With the rush to market add-on boards for the IBM PC user, many products arrive at your doorstep with a multitude of problems. It is therefore a refreshing surprise to find a truly finished product. The Megaplug Board from AST Research is an advanced multifunction board that is well-engineered and has excellent documentation and software.

Sixty-four K of memory is installed on the board. Additional sockets on the board can be used to increase its capacity to 256K. Memory can be further increased to 512K by attaching a piggy-back board with additional sockets. A clock/calendar with battery back-up, dual RS-232 communication interfaces and a parallel printer face are also available on this board.

Software can make or break a good piece of hardware. AST Research has enhanced its Megaplug Board with such features as superdrive electronic disk software, a print spooling program and

two programs for the clock/calendar. Superdrive allows you to allocate memory to the disk emulator in increments of 1K. Most other disk emulator programs require that memory be allocated in 64K chunks.

The Megaplus Board is a first-rate product. It provides the user with a variety of functions while using only one slot on his or her IBM PC. The two communication ports and one parallel port allow the user true flexibility to handle all printer needs. Simple to install, the Megaplus Board gives you a lot of memory and more for a fair price.

AST Research, Inc., \$395 to \$795

MFJ MULTIPLE OUTLET AC POWER CENTERS

Little things like motor noise, radio frequency interference and voltage spikes can subtly work to create chaos in your electronic system. MFJ Multiple Outlet AC Power Centers are designed to eliminate power disturbances that cause system downtime, data and tape loss, and equipment damage.

Available in five types for various set-ups, each features a lighted on/off switch. Interaction between processors, printers and other peripheral equipment caused by power line coupling is eliminated. RFI-PI filters on each line isolate sensitive equipment from power line noise and hash.

MFJ Multi Outlet AC Power Centers need no special installation, adjustment, or tuning. Just plug into any 100 VAC outlet, then plug your equipment into it. They allow your equipment to work without interruption or failure even while high-voltage spikes are being dissipated.

MFJ Enterprises, Inc., 1105 \$49.95; 1106 \$59.95; 1107 \$79.95; 1108 \$99.95; 1109 \$129.95

MFJ-1240 RS-232 TRANSFER SWITCH

A good letter-quality printer can cost as much as, or more than, the computer system it's attached to. For many of us who have several computers, this often results in a condition called printer sharing with its ensuing plugging and unplugging of cables.

The MFJ Transfer Switch is designed to make this process a bit easier. The MFJ-1240 switches 10 of the 25 RS-232 lines. On the back panel are three DB-25 connectors labeled ports A, B, and "Common." If you wish two computers to share a printer or modem, the computers would be connected to ports A and B and the printer or modem would be connected to the "Common" port. Also, the switch could be used to connect a single computer, con-

nected to the "Common" port, with two RS-232 devices, one connected to port A, the other to port B.

The front panel contains two switches and seven LEDs. One of the switches directs the output to port A or port B. The second switch, labeled "TRANSMIT/RECEIVE," swaps lines 2 and 3, which is necessary for two computers or terminals to be connected together. The 7 LEDs monitor seven of the RS-232 lines (TD, RD, RTS, CTS, DSR, CAR, and DTR), which considerably eases the task of troubleshooting the set-up if things don't appear to be working right.

There are two problems you may encounter in using the MFJ switch. First, all three EB-25 connectors on the back of the box are female connectors, which could be the case with your computer as well (Apple and Columbia, for example, have female connectors). One would then have to buy at least one gender changer—a plug with male DB-25 connectors on each end—which can be expensive.

Second, if the serial interface in each computer is set up slightly differently, then you might have to reset the printer's DIP switches each time you switch it between systems. This is not MFJ's fault, but it does cut down somewhat on the convenience of having a transfer switch.

The MFJ-1240 Transfer Switch is a well-constructed piece of equipment. It does what it is supposed to, and the LEDs on the front panel are often useful in troubleshooting RS-232 interfacing problems. Whether or not you will find it useful depends on your particular equipment set-up.

MFJ Enterprises, \$79.95

THE MICROBOT ALPHA

The Microbot Alpha is a self-contained, programmable robot that can lift loads of up to one and a half pounds. Alpha's arm, which has an 18-inch reach, is capable of 330 degree base rotation, 140 degree shoulder and elbow bends, 360 degree wrist rolls, and 180 degree wrist pitch. It can move as fast as 20 inches per second. Alpha can also be programmed for acceleration and deceleration. Its positioning is accurate to plus or minus .00005 inches. An on-board computer can remember 227 working positions. In addition, Alpha can be programmed by other computers through an RS-232C interface by using a proprietary programming language. Alpha comes with 4K of EPROM and ER-PROM and 11K of RAM.

This is certainly not a product for the casual user—it is very expensive. The average user can buy two or three 16-bit computers for the price of one

Alpha. It does, however, have tremendous potential for laboratory and industrial use.

Microbot, Inc., \$8,500

MICROLOG AIR-1

The Microlog Air-1 cartridge turns your Vic-20 or Commodore 64 into a complete radio teletype and Morse code terminal. Just plug in the cartridge, connect a shortwave radio, and you can watch text translated from the transmissions of weather stations, news services, ships, and ham radio operators all over the world.

The Air-1 contains a program in ROM and a radio interface circuit that lets it copy Morse Code as well as all speeds and shifts in radio teletype. On-screen tuning indicators let you get perfect tuning without taking your eyes off the video screen. AIR-1 also tells you what Morse speed you are copying, and it even provides a builtin send/receive code for practice.

Microlog Corp., \$199

MICROBUFFER II

If you have ever shopped for a printer card, you know that there is much variety in the marketplace. Some cards offer straight printing, some offer graphics dump routines, some are compatible with anything and some are not. Now, the clever people at Practical Peripherals have come up with the Microbuffer II. It is available with 16K of on-board memory that is user-expandable to 32K. The whole package fits on a plug-in card that's about twice as long as a normal Apple printer card and contains an on-board microprocessor and software on EPROM to handle the buffering.

You will immediately notice the difference that the Microbuffer makes. For straight printing chores, the card will load a full Apple screen in about two seconds. Because this is a smart card with its own microprocessor, it can also offer 25 text formatting commands and eight graphics commands for dumping the Apple high-resolution graphics screen to the printer. With the 32K version of Microbuffer, you can dump up to 22 pages of text. This is more than enough for the average user.

The Microbuffer is not without faults. Its most glaring flaw is the documentation supplied with the package. The instruction manual is far from complete. It gives you a little here and a little there, but, for the most part, it leaves you to your own devices. In most other respects, this is an excellent product. Its combination of low price and high performance is hard to beat.

Practical Peripherals, 32K \$219; 16K \$199

MICROBUFFER II+

If you do any word processing or graphics printouts with your Apple II and are tired of waiting to use your computer while your printer finishes, then the Microbuffer II+ will solve your problem. Microbuffer II+ is an intelligent buffered interface card that allows your computer to continue working while your printer is busy printing. Additionally, it has firmware (programs in ROM) that enable it to dump a high resolution graphics screen to just about any dot-matrix printer made. It is compatible with the DOS 3.3, CP/M, Pascal and ProDos operating systems. It supports extensive text formatting commands, as well as 40- or 80-column text screen dumps for the Apple IIe and 40-column dumps for the Apple II or II+.

The Microbuffer II+ is sold with 64K, 32K, or 16K of buffer memory (32K and 16K can be upgraded later to 64K) and as either a parallel or serial interface. It is possible, however, to use it as a dual parallel and serial interface by installing a small cable assembly which the manufacturer supplies for an additional fee. Once this cable is installed, the interface can run both a parallel and a serial printer (or other serial device) and, if you like, the printers can print either the same or different files simultaneously. The serial port can only send data, not receive it, and can only run at 300 and 1,200 baud, but this is not a serious limitation for printers or plotters.

If you plan on purchasing a printer (or two) for your Apple, are adding a letter-quality printer to your system or just want to upgrade your system so that it has buffered output, then the Microbuffer II+ is the interface to buy.

Practical Peripherals, Microbuffer II with 64K \$349; with 32K \$299; with 16K \$259; serial or parallel option kit, \$59

MICROFAZER

Quadram's *Microfazer* is a print spooler that doesn't use any of the computer's own memory. It significantly increases the productivity and efficiency of almost any microcomputer system by serving as a print buffer and taking over printing tasks without tying up computer time, allowing the user access to the computer for other tasks.

Quadram has tried to make the *Microfazer* all things to all computers. It is available in parallel to parallel, serial to parallel, and parallel to serial models that offer buffers from 8K to 512K RAM (512K can hold the equivalent of more than 250

typewritten pages). Enclosed in a metal case, it has LEDs on its front panel that indicate pause/copy, read, and error status confirmation. The pause/copy feature allows additional copies of the buffered information to be made at the push of a button. Also, a reset switch is provided that sets the *Microfazer* and clears its memory.

Designed to be used with almost any computer and printer combination, the *Microfazer* is inherently flexible. Also, as it is not permanently attached or configured for any specific printer or computer, it can be used by more than one set.

Quadram Corporation, \$159 to \$1,395

THE MICRONEYE

The Microneye is a low-cost imaging system that can be used with a variety of popular personal computers. Manufactured by Micron Technology, this solid-state camera can record high-resolution images at up to 15 frames per second.

The Microneye comes in three versions. The Bullet (whose name is taken from its cylindrical shape) is a small unit, about 3.5 inches long and 1.5 inches in diameter, that contains a C-mount lens and a 1S32 optic RAM chip. A double-sided circuit board that plugs into a specific expansion slot on each computer handles the interface chores. The Bullet is limited to four feet of cable.

The second version, called the Microneye Camera, encloses all the interfacing electronics as well as the optic RAM in its case. It is connected to the computer by up to 25 feet of standard six-conductor modular telephone cable.

The third version, the RS-232 Microneye Camera, is fully self-contained and connects to a standard RS-232C interface. This version also allows up to 25 feet of cable.

The Microneye software package is menu-driven and quite easy to use. It allows the user to control the light sensitivity of the camera. In addition, the exposure rate can be set to automatically match a user-defined light level. Pictures may be saved on or loaded from the storage medium or dumped to a printer.

Certainly, the images produced by the Microneye are not nearly as good as a photograph, but this product's low cost and motion-detection ability will attract many users. The Bullet version and the Camera version can be used with the Apple II+ and IIe, the IBM PC, the Commodore 64 and the Radio Shack Color Computer. The RS-232 Microneye Camera can be used with almost any microcomputer.

Micron Technology, Inc., Bullet \$295; Microneye Camera \$485; RS-232 Microneye Camera \$540

MICRONIX PREMIUM KEYBOARD

Micronix was the first to make professional keyboards for the TRS-80 Color Computer, and their latest keyboard incorporates a number of features not found on the original or some of its competitors.

Like all other replacement keyboards, this one can be installed by even a complete klutz. It requires no soldering or gluing, and no modifications to the computer's case.

The Premium Keyboard's four function keys with *Versakey* software set this unit apart from most of the others. The combination provides auto-repeat and type-ahead, and strings up to 80 characters long defined as one of the function keys. This means that the user can store often-used key combinations, such as word-processing codes, and access them with a few keystrokes.

The one drawback of this keyboard is primarily aesthetic: It doesn't rest at the same angle as the original. The Premium Keyboard rises up at the front from the computer case, making the unit look like the add-on it is. A few users may also find this slightly uncomfortable.

Compatibility: TRS-80 Color Computer

Micronix Systems Corp., \$79.95; *Versakey* software cassette \$9.95

MICRO VIEW

If you program or engineer microprocessor devices, you can now debug quickly, completely, and inexpensively with a new tool called Micro View from Micro Logic Corp. It lets you debug quickly and thoroughly by giving you a unique view of microprocessor activity on a screen of 256 LEDs. The LEDs show you extensive real-time information (instead of four-digit hexadecimal values) through changing patterns, and because you rapidly associate these patterns with their system function, you often fix bugs in minutes instead of hours. Also because of the large amount of information you can see on the display, you can find and fix problems you were not even looking for.

Various modes let you select address or data; read and/or write; input/output or memory; detailed or overview modes; and one, several, or all pages of memory. The display shows you program flow, memory references, port activity, and hardware/software interaction. You see the program stack as a moving bar graph. You see unstable

electronics and intermittent activity directly. And you see code hot spots for program optimization.

The simple 16-switch console is easy to use and lets you give full attention to your microprocessor. Although Micro View is completely self-sufficient, you can also use it with other devices. By using it as a supplement you get another point of view on those hard-to-fix bugs.

Micro Logic Corp., \$749

MICROSOFT MOUSE

The Microsoft Mouse can quickly move a cursor on an IBM PC's monitor screen. When the user moves the mouse across a flat surface, the cursor tracks this movement across the screen. No specially prepared surface is required. Two buttons on the mouse are used to select decision alternatives or commands from the screen.

Included in the package is the mechanical mouse and a prepared circuit card that functions as an interface between the mouse and the computer. The package's software includes: a programmable interface drive that communicates mouse software instructions to the IBM operating system, an on-screen tutorial and a practice application that teaches the user how to use the mouse, and *MULTI-TOOL Notepad*, a mouse-supported text-editing program.

To encourage rapid acceptance of its mouse by the independent software community and by user/programmers, Microsoft has included a standard interface driver. This driver supports all of Microsoft's high-level languages, including BASIC, FORTRAN, and Pascal. It will simplify the programmer's task of incorporating the mouse into an application program.

The Microsoft Mouse is a low-cost, quality product that gives its purchaser an alternative to total dependence on the keyboard.

Microsoft Corporation, \$195

MODEL 100-EMM

England is invading the U.S. computer market with a host of new products. One of the better ones is an IEEE-696-(S-100)-compatible energy management module. The Model 100-EMM is available from Fulcrum Computer Products. It senses temperatures at four remote locations, provides on/off control for six external devices and includes an eight-source fire or intruder alarm.

Battery back-up of the 100-EMM lets the alarm operate independent of the host computer. The alarm has a 50-millisecond dwell period and three

operating conditions. Temperature is sensed by four pairs of contacts connected to thermistor transducers. Sensor inputs will withstand transient switching voltages, and circuits are included that eliminate false triggering by nearby radio sources. Six relays, rated at 28 amperes, operate independently under software control and can turn air conditioners, water heaters, and other devices on and off.

The Model 100-EMM is suitable for industrial use and is by no means intended to be installed by an inexperienced user. This system definitely requires professional installation and user support. As this is a new European product, it may not be easy to find. The manufacturer can supply names of competent dealers in your area.

Fulcrum Computer Products, price not available

MODEL 8800 GF SERIAL INTERFACE

Designed for IEEE-696/S-100 bus systems, the Model 8800 Serial Interface board provides two independently addressable input/output ports for either RS-232C communications or for optically-isolated 20-milliamp current loops with internal or external current sources. Using jumpers, in Data Terminal Equipment (DTE) mode, this board can be a master to modems and in Data Communications Equipment (DCE) mode, it can be a slave to terminals and printers. An on-board 5.0688-MHz crystal oscillator permits switch-selectable data transmission rates of from 50 bps to 19,200 bps, including a 134.5 bps rate for Selectric typewriters.

The Serial Interface employs type 1602 universal asynchronous receiver transmitters (UART) for parallel conversions, error detection, and serial-data formatting. Characters can be represented by 7 bits or 8 bits and can have odd, even, or no parity, and one or two stop bits.

This board appears to be well-constructed and well-designed. It measures 10 inches by 5.3 inches, is solder-masked on both sides and has gold-plated connectors for superior contact and long wear. It is available in two versions. The certified system component version has been burned in for 200 hours and has a two-year limited warranty. The assembled and tested version has been burned in for 20 hours and comes with a one-year limited warranty.

Vector Electronics Co., \$295 to \$370

MORROW 8088 COPROCESSOR

The Morrow 8088 Coprocessor board lets Morrow's CP/M 2.2-based Micro Decision personal

computers run software written for the CP/M-856 and MS-DOS operating systems. The board consists of two hardware elements: a main processor board that contains the 8088 microprocessor and a Z-80 adapter board. Also included in the package are the MS-DOS and CP/M-86 operating systems and the *SuperCalc 2* electronic spreadsheet program. The board, which plugs directly into the motherboard of the Morrow MD3 or MD11, comes with either 128K or 256K RAM.

The extensive memory added to your system by this upgrade makes it possible to use large spreadsheets such as *SuperCalc*. Users running *SuperCalc* under CP/M 2.2 on the 8-bit Morrow computers had only 29K of memory with which to construct a spreadsheet, far too little for most applications. With CP/M-86, the user has 215K available—more than enough for all but the largest projects.

The real beauty of this board is in its ease of operation. Simple commands move the system control between CP/M 2.2, CP/M-86 and MS-DOS. Because the CP/M-86 operating system is a file on a CP/M 2.2 disk, the user need only boot the computer up with CP/M 2.2, then type one command to enter CP/M-86. For MS-DOS, the user simply inserts a disk after booting the computer up with CP/M 2.2. This is an excellent way to upgrade an already fine computer.

Morrow Computers, \$500 to \$700

MULTI-DISPLAY CARD

The Multi-Display Card from Paradise Systems is a switchable card that allows you to run an IBM monochrome display as well as any kind of composite or RGB color monitor and a parallel printer.

Once again, an outside vendor has done Big Blue one better. Paradise Systems' Multi-Display Card has overcome an expensive and space-consuming problem with a simple, inexpensive fix—\$600 and one card replace about \$1,000 and two cards. Further, one easy control command and the throwing of a switch replace the inconvenience of two programs.

The Multi-Display Card is easy to install. Two switches on the IBM motherboard and one on the display card are set. The programs tested ran very well. Crisp characters appear on the color and on the monochrome monitor in every case.

In summary, this is a well thought-out board that fills a need. The documentation was very well done—illustrations were clear and simple, and the text was arranged in a logical order and was very easy

to read. The only things one might find fault with are the ports. Three interfaces are required—one for the printer, and one for each monitor. The back of the card does not have enough room for three such ports; on one, cable must be attached to an adjoining slot or left to hang over the back.

Paradise Systems, Inc., \$595

MULTILINK

A local area network is one alternative to having two or more complete systems with multiple hard disks, printers, software and duplication of your records. Such a system for IBM PCs is Davong's Multilink from Davong Systems.

The Multilink starter kit for three user stations includes all cables and linking software. After installing a network interface board in each of the IBM PCs to be linked, the cables used for hooking up the Multilink can be connected to each computer, if only two PCs are to be linked. The two PCs can be up to 2,000 feet apart. For a network three or four PCs, the computers must be interconnected by a passive resistor splitter called a Hub 4. In this case, each PC must be located within 100 feet of the Hub. Each fixed disk in the network must be shared; among all of the computers, current software will not allow any PC in the system to have exclusive use of a fixed disk.

Davong's Multilink hooks the IBM PC into a powerful, high-performance network. While the system is friendly and transparent to the user, it is a difficult system to install. The software installation is not a simple task. Many steps are required and the documentation supplied by Davong is not helpful. The instructions are confusing, totally unorganized, and poorly written. Drawbacks aside, this is a reasonably priced system that does the job effectively.

Davong Systems, \$2,395

MULTI-PAK INTERFACE

The Color Computer's one ROM port limits expansion of its hardware capabilities. Radio Shack has recognized this problem and solved it with the Multi-Pak Interface. It gives the user four expansion slots that can be controlled by either a switch or the keyboard.

Before the Multi-Pak was available, disk drive owners had to unplug the disk controller cartridge whenever they wanted to use the ROM port for something else. Not only was this bothersome, it was potentially hazardous to the computer. Plugging in or unplugging ROM packs with the power

on can short out a number of microchips inside the computer.

The Multi-Pak plugs into the ROM port. It matches the contour of the Color Computer, making itself an attractive addition. The user can leave it in the ROM port permanently but, since Radio Shack uses tinned connectors, the Multi-Pak should probably be removed periodically to clean off corrosion. This can be easily done with an eraser. Multi-Pak has its own on/off switch and its own power cord.

Perhaps the biggest advantage to having the Multi-Pak is that it gives the user access to more than one hardware device at a time. For instance, with Radio Shack's X-Pad, a disk drive and the Multi-Pak, a user can create screen graphics and store them on disk.

The Multi-Pak is not for everyone. The average user may never have a need for it. But for those who want to get the most out of their Color Computers, it's essential.

Radio Shack, \$179.95

MULTIPLE ADAPTER INTERFACE

The Multiple Adapter Interface is a standard size circuit board for the IBM PC that packs a lot of utility into just one expansion slot. This plug-in module from Amdex provides memory extension, monochrome and color video interfaces, and a printer adapter.

The documentation and software with this package are very well done. Clear and concise instructions are provided for installation and use of this well-made board. Even a novice user will have this product up and running in a short time.

The Multiple Adapter Interface comes complete, with no addition options available. It contains 128K of RAM which is user-allocated to particular functions. A two-position DIP switch is used to configure the board for monochrome video display or color graphics applications. A second DIP switch either allocates 96K to user memory (leaving 32K for use in the video mode) or allocates the full 128K to the video mode. The board can operate in any of the four IBM-compatible modes for color graphics: 40 by 25 alphanumeric, 80 by 25 alphanumeric, 320 by 200 four-color or 640 by 200 black-and-white.

With its 128K of RAM, the Multiple Adapter Interface offers the user exceptional picture enhancement. Text is crisp and clear, with no fuzz around the edges. Colors are crisp, clear, and vivid. Designing pie or bar charts with text overlays is easy with this board. The Multiple Adapter Interface is a worthwhile addition to any user's IBM PC.

Amdex Corporation, \$799

NET/ONE PERSONAL CONNECTION

The Net/One Personal Connection is an EherNet-compatible network interface unit that facilitates link-ups between IBM and Texas Instruments personal computers. This plug-in board can also link these computers to mainframe systems by the IBM System Network Architecture protocol.

Net/One allows its users to run any software under PC-DOS or MS-DOS without modification. In addition, software can be shared across the network. Five new user commands (supplied in software packaged with the Net/One) to PC-DOS/MS-DOS make this networking possible.

The Net/One Personal Connection also features an optional shared disk server and printer server which execute Disk Share and Print Share software supplied by the manufacturer. The disk server manages shared access to all files and application programs stored on one or more hard disks at the server station. Disk Share also provides multi-level password protection of files. Print Share manages access to printers attached to the network. Output from application programs or from the keyboards can be automatically spooled to a networked printer; this frees the workstation for new tasks before the printing is completed. Net/One can give workstations access to many disk and print servers simultaneously.

The Net/One certainly deserves consideration for multitasking in offices and factories. It is well-conceived and realistically priced.

Ungermann-Bass, Inc., Board \$850; software \$500 per server

NETWORK 216 AND MONITOR 16

The Network 216 and the Monitor 16 allow two-way video and audio communication between a master station and each of its satellites and communication between all stations and peripheral devices. This system, created by Wolsten's Computer Devices, is designed for any situation in which more than one Atari computer is used at a time, such as in a computer class. A dedicated computer is not required.

The Network 216 scans up to 16 active Atari computers and asks whether any action (such as uploading or sending data to a printer) is required. It automatically proceeds from one active computer to another, skipping inactive units. Its data rate is 19,200 bytes per second. The Network 216 uses Atari DOS and can handle up to four disk drives and a printer.

The Monitor 16 expands and enhances the system. It can select, at the turn of a dial, and monitor any one of up to 16 Ataris at a time. Used with any television set, the Monitor 16 can display the video screen that appears on the selected computer. Audio communication is made possible by a headset with an attached microphone.

The Wolsten system has been successful in schools. Monitoring the workers in a commercial computer room is one of the many other possible uses for this system.

Wolsten's Computer Devices, Inc., \$1,195

THE OMNITRONIX INTERFACE

The Omnitronix Interface is a low-cost RS-232C interface for the Commodore 64 Personal Computer. It plugs into the user I/O port of the computer and converts the Commodore TTL signals to true RS-232C. A two-foot cable attached to the Interface ends in a male DB25 connector. The Omnitronix lets you drive most serial devices, such as modems and serial printers.

The Interface's complete documentation contains a machine-language printer driver program, a BASIC dumb terminal program and information on how to list a BASIC program on a serial printer. The documentation is of a higher quality than you would expect of a product at this price level, and it appears to be error-free.

The Omnitronix Interface is guaranteed to work for your application, and work it does. This may be the least expensive way to enable true serial communication for your Commodore 64. But, before you begin to think that this product is all things to all serial peripherals, consider that this interface is not intelligent. This means that it cannot convert Commodore control characters to standard text for listing and printing. To be fair, though, how much more can you really expect when you are already getting a great product at a great price?

Omnitronix, \$39.95

128KDE SOFT DISK

Legend industries' 128KDE Soft Disk is a general-purpose 128K memory expansion for Apple II, II+, and IIe. It occupies any expansion slot (except slot zero) and comes equipped with a ribbon cable that plugs into a motherboard socket from which a RAM chip has been removed; 128KDE cards may be installed, even in combination with other memory expansion boards.

This card comes with support software for Apple DOS 3.3, Apple Pascal or CPM (to be used when

CPM is provided by a Z-80 coprocessor). The card is to be used as a high-speed memory disk or soft disk under any of these operating systems, to allow the computer to be used as if it had an additional disk drive.

The 128KDE has some limitations. The soft disk may not be accessible to some commercial software run under Apple DOS. This problem doesn't happen under CP/M or while programming with *Applesoft* or *Integer BASIC*. However, because the soft disk function is built into a modified operating system, any software that has its own customized operating system (including most copy-protected programs) will be unable to set up or to use the memory disk. Also, this card is volatile memory—its contents are lost during power interruptions, reboots and system resets.

When 128KDE is installed in slot zero, it may be used as a replacement for a 16K RAM card or language card. The "DOS mover" program supplied with the card can be used for DOS relocation, in order to provide as much as 176K of working memory for programs.

Legend Industries, Ltd., \$650

OPTOMOUSE

One has to wonder where the term mouse, much less smart mouse, comes from. How did we come to call computer input devices after this despised rodent? Now to add insult to injury, we have OptoMouse from USI Computer Products. Names aside, OptoMouse is a smart mouse, which comes equipped with an on-board microprocessor to provide accurate cursor positioning and graphics input. OptoMouse is designed to be used with virtually any microprocessor system.

The OptoMouse is about the size of a pack of cigarettes and it has a single button. It is designed to be moved back and forth over a thin, reflective grid. This motion is then translated into a corresponding computer input and appears on the screen. It can be used to initiate action, to aid in word processing, or to draw graphics. One big advantage of this mouse is it does not take up an expansion slot in your computer. Nor does it require a keyboard with a special option port. It has its own on-board power supply and uses a standard RS-232 serial interface to connect to virtually any microcomputer.

While most mouse-type input devices do not work well with games and are only adequate when used for graphics, the OptoMouse is somewhat better. The interaction between hand and eye is somewhat improved by the necessity to stay within

the reflective grid's perimeter. If you must have a mouse, this one is better than most.

USI Computer Products, \$179

ORCHESTRA-90

Orchestra-90 is one of the most impressive hardware add-ons available for the TRS-80. If all you have heard is bleeps and bleeps from your cassette port, you owe it to yourself to hear a demonstration of Orchestra-90. You simply will not believe the music your computer is capable of making. This product was first distributed by Software Affair, Ltd.; Radio Shack acknowledged its popularity by adding it to their product line.

Orchestra-90 includes a small box that connects to the bus of your TRS-80 and provides two RCA phono jack outputs that connect to any stereo amplifier. It also comes with an elegant piece of software that lets you enter, compile and play music. You can save music files on disk or on cassette.

The Orchestra-90 music editor is full-screen. Its professional, typeset manual explains how to transcribe sheet music into the simple Orchestra-90 notation. This music notation lets you enter everything from whole notes to sixty-fourth notes, staccato, to articulation, dotted notes, triplets and even percussive effects. The musical notation uses labelled measures to let you tell Orchestra-90 to play only a portion of your song while you are creating it. It also lets you repeat any part, allowing you to build lengthy songs with a compact music file.

Five independent voices can be synthesized at once. A voice is a thread of musical notes. Having five voices is like having a chorus of five untiring singers under your direction. The stereo effect is achieved by directing two voices to one channel and three to the other.

Even if you don't want to type in music, if you have a modem you can get lots of music files from public bulletin boards and information services such as CompuServe. Some of this music is truly inspired. If you want a break from numbers and words, check out Orchestra-90.

Radio Shack, \$79.95

ORCHID GRAPHICS INTERFACE

IBM gives you a choice between two kinds of adapters and monitors to be used with your PC. You can use monochrome adapter boards with monochrome monitors to produce really fine quality text. As an alternative, you can combine IBM's color adapter board with either a monochrome or a color display monitor to produce graphics on your

screen. In either case, you must give up something to get something. The monochrome board leaves you without graphics capability. The color graphics board lets you draw pictures, but the price is a significant loss of resolution. The Orchid Graphics Interface board attempts to solve this problem.

The Orchid board provides high resolution graphics for a monochrome display. It will not work with a color monitor. Having its own on-board 64K of memory, it is capable of maintaining two separate pages of graphics images at the same time. The Orchid board is easy to install and, once in place, it produces spectacular graphics as well as crisp, clear, easy-on-the-eyes text.

However, as usual, you must give up something to get something. The Orchid package has serious documentation and software problems. The documentation is awful. The Orchid software called Halo has many basic errors. Its screen dump problem is probably the worst. Halo considers the screen's ratio of height to width to be different than that of the printer. This means that the image printed will not be exactly the same as the image you produced on the screen.

Considering the quality of graphics produced by the Orchid Graphics Interface board, it may be worth your while to overlook its software and documentation shortcomings.

Orchid Technology, \$395

PBH'S COCO SERIAL/PARALLEL INTERFACE

The Color Computer has a unique problem when it comes to printers—it is incompatible with all of the popular parallel interface brands. Radio Shack chose to use serial output for the CoCo's printer port.

A number of serial-to-parallel converters on the market are designed to change the CoCo's serial signal to parallel. The pbh converter does this, and it also has features found on none of its competitors.

The CoCo Serial/Parallel Converter allows the Color Computer to work with any parallel-interface printer with a Centronics-type cable. This includes popular brands such as Epson, Okidata, Gemini and C. Itoh. The pbh converter allows the CoCo to match any printer's rate of data transmission, from 300 to 9,600 baud.

The CoCo Serial/Parallel Converter has a separate switch that toggles the CoCo's serial port between a printer and a modem. This is important if the user must use the serial port for both of these peripherals while on line to an electronic database or bulletin board.

Pbh includes all the cables (to the printer, modem, computer and power outlet) with the unit. The converter has its own power supply, so it never drains the computer's power.

At nearly \$90, the CoCo Serial/Parallel Converter is at the top of the price range for this kind of device, but it has features that would cost extra on other units.

pbh Computer Products, \$89.95

PC BUBBLE

Finally there is an add-on bubble memory board for the IBM PC or XT. A half megabyte of memory is offered on Helix Laboratories' PC Bubble Board. This board is designed to emulate a mini-Winchester disk and fits into a single IBM expansion slot. All solid state, the PC Bubble has four one megabyte Intel 7110 bubble memories, a 40-millisecond access time and a data transfer rate of 400,000 bits per second that make it many times faster than a floppy disk. The PC Bubble is designed to run under most operating systems, including MS-DOS-2.0, CP/M-86, and Softech Pascal 1V.13, and it responds to fixed disk commands for these systems. Although the PC Bubble Board was not tested on these machines, Helix Laboratories claims compatibility for the Corona and Compaq computers.

Arriving with a complete and readable manual, the PC Bubble Board is easy to install and to operate. Testing showed the board to be error-free in its working mode, and its complete silence was wonderful, if at first unnerving. As its memory is non-volatile, the PC Bubble Board opens up wide vistas of possible use. Gone is the need for backup batteries and, as a bubble memory uses less power than a floppy disk, the available power for other add-ons is greater.

It is refreshing to find a package as complete and as useful as the PC Bubble. Everything worked as claimed and the documentation was a joy.

Helix Laboratories, \$1,495

PC CLUSTER

Local area networks are one solution to the problem some offices have when several desktop computers must share data bases, printers, and hard disks. Now there is a product on the market that acts like a local area network without being one: It's called the PC Cluster from IBM. Ironically, IBM does not claim the PC Cluster to be its real offering in the LAN field. However, this product clearly functions as a low-level local area network.

The PC Cluster adapter allows the IBM PCs, PC

XTs, and the Portable Computers to be attached in a clustered configuration much like a LAN. The PC Jr. Cluster attachment lets you include Junior in the system. The cluster uses a coaxial cable in a linear bus configuration, with drop lines that connect the bus to the computers in the cluster. The system costs less than other LANs that can accommodate IBM PCs, but its functions are limited, too. The Cluster program allows users to transfer files from one PC to another at the fairly slow rate of 375K bits per second. It does not allow file sharing or printer sharing. This was predetermined when IBM decided to use the CSMA/CA (Carrier-Sense Multiple-Access with Collision Avoidance) protocol as opposed to a token-passing ring.

Some people will no doubt feel that IBM has gone their own way once again, this time producing a product that has limited use and will be bought only because of IBM's name. Actually, 30 or 40 percent of the users who would otherwise buy a competing LAN system will find they can do just as nicely with the PC Cluster. This time IBM has come up with a Model T that is really a Lincoln in disguise.

International Business Machines, Each adapter \$340; Each cluster kit \$110; PC Cluster attachment \$400

PC 4-PACK

The PC 4-pack is a four-function memory expansion board for the IBM PC. It contains the by-now-standard 64K of memory expandable to 256K, an asynchronous RS-232C communications port, a parallel printer port and a real-time clock/calendar with battery back-up.

This well designed board accepts socketed memory chips in 64K increments up to its full load of 256K. Parity checking is included, and on-board DIP switches provide selective addressing of any of the 64K rows.

The RS-232C communications port includes a standard DB 25-pin connector, and its baud rate, word length, and stop bits are software-programmable. Jumper selection allows the serial port to be addressed as COM1 or COM2. This port can be used for connecting such serial devices as modems and RS-232C printers.

The Centronics-standard parallel printer port comes equipped with a cable. Jumper selection can configure this port as LPT1 or LPT2 without interfering with the operation of the parallel printer port on the IBM PC monochrome board.

The real-time clock/calendar is software-pro-

grammable. It includes a backup battery that will keep this feature functioning even when the computer is turned off.

The PC 4-Pack does nothing different from other IBM PC expansion boards, but what it does, it does well at low cost. The documentation is about average; however, the software provided is above-average.

DATA Impact Products, Inc., \$395

PC GT

An alternative to a local area network is here. Less expensive and easier to install, understand, and use, the PC GT from Sierra Data Sciences works like a charm. Your IBM PC or XT can handle up to three PC GT cards to accommodate up to seven users at one time.

The PC GT does not have access to the RAM of the host computer. It comes with its own 80186 microprocessor and delivers 128K of RAM per user. This is expandable to 512K of RAM per user. With a clock speed of 6 MHz, compared to the IBM PC's 4.77 MHz, the GT has a 20 percent speed advantage. The PC GT provides a second, faster, more powerful computer in your PC. Two users can share each GT expansion card while someone else uses the host computer.

The multitask capabilities of the GT require special software called MX-DOS, written by Sierra. Installation software sets up the control sequences needed to talk to the terminals and is used only once. The documentation supplied is very good. Installation can be easily accomplished by anyone who knows their way around computers.

Small business users will do themselves a favor by looking into the PC GT. Almost any dumb terminal will function well with it. For thousands of dollars less per user than the cost of a networked system, a PC can accommodate additional users. While the GT is not as expandable as a network, it could handle the needs of many small businesses, especially if it is used in a system that has a hard disk.

Sierra Data Sciences, PC GT \$1,095; MX-DOS \$195

PC-MOUSE

Most users have one of two attitudes about mice and computers. One attitude is that it is so simple and natural to use a mouse that in a short time you feel as though you are using mental telepathy to communicate with the screen. The other is, as one computer executive put it, "The mouse is the perfect pointing device—for a person with three

arms." Obviously, personal preference determines whether or not a mouse is easy to use.

The PC-Mouse is an optical mouse, an improvement over the earlier mechanical mice. Mechanical mice sense motion by recording the movement of a ball across a flat surface. The PC-Mouse uses a LED to provide light that reflects off a special pad to a semiconductor sensor inside the mouse. It has three buttons which can be operated with one or several fingers, as you prefer.

Mouse Systems, the manufacturer of PC-Mouse, supplies menu-driven software for several popular programs. These include *Lotus 1-2-3*, *WordStar*, *Multiplan*, *VisiCalc* and more. It also promises a future release of software that will permit users to design and customize menus for all IBM programs.

The PC-Mouse's documentation falls somewhere between good and excellent and provides easy installation instructions. Plug the interface box into a wall socket, connect an RS-232 cable to the IBM PC through the COM 1 or COM 2 port, then connect the mouse cable to the interface box, and you are ready to run.

The PC-Mouse is a well-engineered product. Mouse Systems provides a one-year warranty that covers materials and workmanship.

Mouse Systems, \$295

PC-NET

Does your company need to hook up 64,000 computers in a network? That is what the PC-NET from Santa Clara Systems will let you do. Actually, though, the 64,000 figure is somewhat limited by the amount of cable permitted in the system of computers to be linked.

PC-NET was designed specifically for the IBM PC and its PC-DOS operating system. It allows your microcomputers to share such costly hardware as hard disk units and letter-quality printers. Floppy disk drives, modems, and internal memory can also be shared. All of this sharing means that your per station costs are reduced. Although it is recommended that you do not install it yourself, all that is required for installation is to slip a PC-NET board (it must be plug-compatible) into an IBM PC and to connect it with a 75 OHM terminated coaxial cable.

The software provided with PC-NET allows disk sharing, file locking, and multitasking. Disk sharing allows PCs to share hard disks installed in other PCs. The shared disk appears to be locally attached. Since only the one shared disk needs to be backed up, backup problems are simplified.

In order to share expensive resources such as printers or communication lines and to perform

multitasking, the PC-NET provides for remote execution. This allows a user on one PC to run a command on another PC as if the command had been entered on the remote PC's keyboard.

While it is not priced for the casual user, PC-NET does offer value. The savings per user can be immense; also, while all the PCs in the network share the same peripherals, they remain independently productive.

Santa Clara Systems, Inc., starter kit (includes first 2 stations) \$1,100; each additional station \$495

PC-1 AND PC-2 PORTABLE CONVERSION SYSTEMS

The PC-1 Conversion System converts desktop IBM PCs into transportable PCs. The PC-1 is built into a very strong yet lightweight internal aluminum chassis. It is enclosed in a stylish and extremely durable plastic case. Its rugged construction provides excellent RFI screening.

To convert your PC, you remove its main circuit board and install it in the PC-1 case. The PC-1 also houses a monochrome display adapter card, one or two disk drives, an asynchronous communications adapter, an amber 9-inch high-resolution display, a switching power supply, a cooling fan and a side-mounted panel with connector openings that match up with those on the back of the IBM PC. The PC-2 has, additionally, a Colby IBM-compatible keyboard.

Colby Computer, PC-1, \$899; PC-2, \$1,188

PC PROBE

The PC Probe consists of a circuit card and software on a floppy disk. It is a powerful debugging tool for anyone who develops programs on an IBM PC or its equivalent.

Use of the PC Probe will greatly reduce the time and effort it takes to get programs running on the PC, because the Probe has access to all of the PC's bus signals. The Probe features advanced breakpoint capabilities, real-time trace, symbolic debugging, macro commands, memory protection, program crash recovery, and program patching.

The PC Probe circuit board fills one IBM expansion slot. It contains an RS-232 port and a serial interface driver for an external CRT.

This is a truly fine system that will simplify and speed up the professional programmer's work.

Atron, \$2,495

PC WEIGHTMATE

How many times have you held a letter or package in your hand and asked yourself, how many stamps do I use? If you are like most people, you will want to be safe, so you'll put on more than enough. For an office that does a lot of mailing, that's wasting a great deal of money. Take heart; Micro General Corporation is rushing to your aid with the PC WeightMate.

The PC WeightMate is a scale system that converts the IBM Personal Computer or Apple II to an electronic scale. The WeightMate consists of a 25-pound capacity scale, which is plugged into a rear slot in the computer, and a floppy disk, which contains the menu-driven software. The software includes rate tables and zone charts for all classes of United States Postal Service domestic and international mail, as well as United Parcel Service and Federal Express.

To use the WeightMate, place a letter or package on the platform; the machine instantly displays the correct rates for any service class and zip code or country selected. It also has a *Rate Shopper* program, which tells the best way to send a given package. All of the operations can be accomplished in one or two keystrokes, and no training is necessary. Updating the software can be accomplished in one of two ways. For \$39 per update, Micro General will notify you of a rate change, and you can request an updated disk. The second option is to purchase an insurance policy which will cover all changes for a period of 18 months. This service costs \$98 and is well worth it.

Micro General Corporation, \$695

THE PCOX 3270 EMULATION PACKAGE

There is no longer any doubt that the IBM PC has achieved big business acceptance. Perhaps the single most important reason for this is its ability to communicate with mainframes. One way this is accomplished is by emulating a 3270-class workstation, thereby gaining the ability to manipulate mainframe data. It is probably only a matter of time before this smart terminal completely displaces the dumb terminal.

One of the newest of the emulator devices is the PCOX from CXI. PCOX is a piggyback option board that plugs into any expansion slot on the IBM motherboard. It can be connected via coaxial cable to a channel-attached IBM 3274 Cluster Controller or a remote BSC or SNA/SDLC IBM 3274 or 3276. Excluding the 132 character wide display of the 3278-5 and the graphics of the 3279, PCOX can

emulate the whole 3278/3279 series: big screens, color and all.

PCOX requires an IBM PC or XT with a minimum of 64K bytes of memory, and at least one floppy-disk drive. The monitor can be monochrome or color and it runs with PC-DOS version 1.1 or 2.0. The software operates as a transient program, in memory only when it's actually needed. With 96K bytes or more RAM, the routines remain resident, offering substantially faster response. For people in a user community, or consultants and analysts, or people who have multifunction jobs where they are doing mainframe and micro work, the PC-Plus Emulator is the way to go, and the PCOX board is a good choice.

CXI, \$1,390

PD 100

The Prototype Development Board (PD 100) connects customized circuitry to an IBM PC. The PD 100 has a switch-selectable address decoder. A rocker switch allows it to select up to four unique addresses that do not conflict with other IBM PC peripherals. Reliable operation is ensured through the use of plated through holes, gold-plated sockets and edge connectors.

Almost half of the board is set up for the installation of I/O connectors. The other half is composed of a grid of more than 1,600 pads that are suitable for the soldered installation of up to 40 wire-wrap sockets.

A manual, available separately, includes detailed diagrams of circuits of I/O ports, A/D and D/A converters, transducers, and other useful interfaces. Selling this excellent user's manual separately is a nice money-saving touch. In developing a new expansion board for the IBM PC, a user may go through several PD-100s but will only need to buy one manual.

The PD 100 board's construction is rather flimsy, but the board is laid out in a logical sequence that is easy to work with. Best of all, there is absolutely no conflict between the PD-100 and other expansion boards already installed in other slots on the IBM motherboard.

Real Time Devices, \$99; manual \$20

PDQ II

The Motorola 68000 Microprocessor chip is one of the most powerful chips around today. Now you can put it to work in your Apple II, II+, or IIe, with the PDQ II board from Enhancement Technology

Corporation. The PDQ II will not only let you run 68000 software, but will let you develop it as well.

The PDQ II is actually a two-board set. One board contains the MC 68000 processor, and the other carries 256K bytes or more of RAM. They occupy two slots on the Apple motherboard, and are connected with their own 60-pin bus connectors. As shipped, the two boards require adjacent slots to allow the 60-pin connector to reach between them. If you have only nonadjacent slots available, you can order an optional extender cable.

Two problems the people at Enhancement Technology had to overcome were the limited current available from the Apple power supply and the higher-than-usual temperatures generated by the MC 68000. As a solution, they have included a combination fan and power supply that mounts on the rear left edge of the Apple case. The additional power is supplied only to the double PDQ II board by means of a 16-conductor cable that is included. The PDQ II package also includes two high-level software systems, an Applesoft-compatible BASIC, and the UCSD p-System. As an option you can order the system with a Pascal compiler. PDQ II won't turn your Apple II into a Macintosh or a Lisa, but it's the next best thing, with speed and the ability to run large 16-bit programs.

Enhancement Technology Corporation, \$995

PERSONAL PENPAD

Being afraid of a computer keyboard has prevented many potential users who have always used longhand in their work from buying computers. The Personal Penpad from Pencept has mated the skill of writing by hand to the IBM PC.

The Personal Penpad consists of a writing tablet, a controller, and a serial interface. The Penpad uses only memory that is part of its own controller interface; therefore, only software that uses the Penpad data as input requires PC memory.

The writing tablet is divided into two sections—a "forms" area for entering data and a "command" area for sending commands to the software used. The Penpad's paper has a printed grid that corresponds to the electronic grid mounted in the tablet. Penpad's controller is a flat rectangular box that is designed to sit between the PC's system unit and the monitor.

The Personal Penpad is easy to use. An ordinary ballpoint pen cartridge that is fitted to a stylus and attached to the controller is all that you need for writing. Penpad accepts block letters A to Z, numerals 0 to 9, and 15 other characters. Once it is written on the grid form, a character is interpreted

and flashed up on the PC's screen. If the character cannot be interpreted, a question mark will appear on the screen instead.

A keyboard is faster and more flexible than the Penpad, but the Penpad may encourage people who don't type well to use computers.

Pencept, Inc., \$995

PION INTERSTELLAR DRIVE

If you own a computer and you're not thirsting after a disk emulator, it's probably because you don't know what you're missing. These devices do for computers what jet engines do for aircraft: They speed things up considerably.

In most ways, PION's Interstellar Drive is typical. It uses the same kind of memory chips as you will find in your computer's RAM, or main memory, but from your computer's point of view, it looks like a disk. This means your computer will read files from it and write files to it, and generally treat it as if it were a disk. Except that everything will happen *much* faster: 5 to 10 times faster than a hard disk, 50 to 100 times faster than a floppy. The stripped-down version of the Interstellar Drive has 256K memory. You can expand it 1 MB.

There is hardly anything that you can do with a computer that can't benefit from using a disk emulator. Spelling checking is an obvious example. A 7,000- or 8,000-word file will take minutes to spell-check using floppy disks. With a disk emulator, the time is measured in seconds. The benefit becomes even more obvious with a program like *ProofReader*. *ProofReader* is a good spelling checker, but when correcting a file, it forces you to wait after each correction while it writes the correction to disk, then searches for the next error. With a disk emulator, there is no significant wait between words.

Less dramatic, but no less important, a disk emulator can speed up programs that have to dip into disk files occasionally for orders. *WordStar* is a good example here. Some commands in this program aren't loaded into the computer memory until you need them. Then the program goes to the Overlay file on the disk to look for its orders. The wait is only a second or two, depending on your system, but it can be annoying. With the PION, there is no wait.

All this applies to any disk emulator. The Interstellar Drive also has two distinctive features that make it special, if not unique. First, instead of coming in different models for different computers, it comes in a single model, with a choice of interface kits for particular systems. If you switch to another

computer, you only have to buy a new kit to be able still to use the drive. This is fortunate, because once you use a disk emulator, you won't want to be without one.

More important, perhaps, the PION has its own power supply and battery backup as standard. The battery backup is good for about half an hour. With other disk emulators, saving a file to "disk" is no safer than not saving the file at all. If you have a brownout or transient power failure, you've lost the file. And, of course, when you turn the computer off, you lose the files, too.

With the PION's battery backup, a file saved to the Interstellar Drive is almost as safe as a file saved to disk. Even nicer, the independent power supply means you can turn off your system without turning off the PION. This lets you pick up at the next session right where you left off, without having to copy all your working files back to the Interstellar Drive.

This does not mean that saving files to the PION Drive is as safe as putting your files on a disk, and it certainly does not mean that you shouldn't make backups on real disks. But it does mean that, most days at least, you can save a few minutes of start up time by having your working files already loaded on the PION. And saving time is what disk emulators are all about.

Compatibility: Interface kits are available for IBM PC (PC DOS or CP/M-86), Apple II and II Plus (DOS 3.3, Pascal 1.1, CP/M 2.x), TRS-80 III (TRSDOS 1.3, LDOS), TRS-80 II (CP/M 2.x), S100 bus systems (CP/M 2.x, NORTHSTARDOS), SS 50 bus systems (FLEX 9, OS-9), Digital Q BUS (TR-11, V4), generic Z-80 systems (CP/M 2.x)

PION, Basic Unit with 256K \$1095; 256K expansion memory \$595 each; Expander Kit (for one to three expansion memory boards) \$75; Additional interface \$150

POLAROID PALETTE

The Polaroid Palette is an interactive film recorder that produces high-quality, black-and-white or color, 35-mm slides and instant photographs of computerized images. Featuring a flat-faced, medium-resolution, monochrome video screen with a tricolor filter wheel, the Palette allows even monochrome graphics displays to produce color prints. The Palette connects to the computer through black-and-white video and RS-232C lines.

The Palette's interactive software matches exposure parameters to the film used and allows the user to control color selection and location. The

software also lets the user transfer images from the computer display to film without modification.

Palette can be used with Apple II+, the Apple IIe and the IBM PC. The package includes the software programs, a 35-mm camera back, an adapter plate and the transparency system hardware.

The system supports several different graphics packages and produces a superior 35-mm slide. The instant photographs are not as good as the slides, but they are nonetheless of a very fine quality and are suitable for many uses. The operations manual sets a standard for the rest of the industry to follow. This is a high-quality product with no apparent faults.

Polaroid Corporation, \$1,300

POWER-R MODEL 100-2124-00 VIDEO ENHANCER

It has always been a fact of computer life that you don't get as clear a monochrome screen when using a color graphics adapter as you do with a monochrome adapter. The Power-R Model 100-2124-00 Video Enhancer eliminates the grainy texture commonly seen on IBM PC screen displays when color video output is used to drive a monochrome monitor.

The Power-R is connected between the PC and the monitor. It uses a nine-pin connector that houses a miniature circuit that translates the video signal and amplifies it to make it more acceptable to the monochrome monitor. The device includes a five-foot cable to connect it to the video monitor and an 18-inch cable to plug into a light-pen outlet.

Once it is connected to the IBM PC, the Power-R device converts an RGB color into 16 monochrome shades. In tests run for this review, the Video Enhancer functioned perfectly with IBM's color graphics adapter board, Amdek's MAI, Plantronics' Colorplus, Tecmar's Graphics Master, USI's Multidisplay and Mylex's Chairman boards. One very big disappointment is that the Power-R will not function with the IBM monochrome monitor. As most IBM purchasers opt for the IBM monitor at purchase time, this makes this inexpensive product very impractical for many users.

Power-R, \$79.95

POWERPAD

The PowerPad, from Chalk Board, Inc., is a touch-sensitive input device for personal computers. Like its competitor, the KoalaPad, it is designed for drawing directly on a video screen and

can be used as an alternative to the computer's standard keyboard. Its major advantage over the KoalaPad is its larger size—the actual surface of the pad is about 12 inches square. Unfortunately, the pad's size, its intentions and its packaging are about all that the PowerPad has going for it. The version reviewed for this book was designed for the Commodore 64. Other versions are available for other computers. Available software for use with the pad is furnished on cartridges and includes programs for graphics and music as well as educational programs for math, science, language arts and social studies.

The two programs reviewed, *MicroMaestro*, a music generator, and *Leo's 'Lectric Paintbrush*, an elementary drawing program were extremely simple and didn't seem to take advantage of either the computer's or the pad's capabilities. The graphics program, for example, was too slow to keep up with drawing on the pad and its resolution was crude.

Each program comes furnished with a large mylar overlay to define the surface of the pad as keys. Also included are well-written instruction books that can serve as study guides for children and experimenters. In general, the instruction books as well as the ideas behind the PowerPad and its series of intended application programs (called *Leonardo's Library* after DaVinci) are several cuts above the quality of the actual hardware and programs.

The usefulness of the PowerPad is limited by its design. It is an entirely digital device and its surface is a matrix of only 128 by 128 switches. Unfortunately, this is far less than the screen resolution of most personal computers. It is also not a simple matter to write your own programs for use with the PowerPad. Chalk Board sells, separately, a programmer's kit that includes a blank overlay, some marking pens, and a slim volume that explains its operations.

PowerPad seems like a good idea that isn't successful as an actual product. Still, the PowerPad and its programs may be useful and appealing in some classrooms or in homes with small children.

Chalk Board, Inc., \$99.95

PRARIE POWER

Prarie Power is a rechargeable, lightweight, external battery system that is completely compatible with Radio Shack's Model 100, NEC's PC-18201A, and other six-volt briefcase-sized portable computers. The batteries come in three sizes that are lightweight and small enough to fit in the palm of your

hand. Prairie Power comes with an attached six-foot, six-volt cable.

Although top-rated alkaline batteries can run the Model 100 for barely 20 hours and expensive nicads can run it for only a few hours, the Prairie Power 8-ampere-hour unit can run the Model 100 continuously for over 150 hours. In tests run for this review, it ran for over 160 hours. The 5.5-ampere-hour battery supplies 100 hours of usable power, and the 2.6-ampere-hour model supplies 50 hours and is only slightly larger than a pack of cigarettes.

Prairie Power features immobilized electrolyte construction. The batteries use a double-sealed, fluid-stabilized, lead-calcium system that can go anywhere and be used in any position. Prairie Power requires no conditioning and has no memory to prevent complete recharging. An optional battery charger is also available.

Bluestem Productions, \$21.95 to \$34.95

PREMIUM SOFTCARD IIe

The Apple II has one of the largest software bases in the computer industry, while CP/M has become the de facto operating system in the 8-bit computer world. Because the Apple II uses a 6502 microprocessor, it cannot run CP/M, which requires a Z-80 processor. Now, Microsoft has solved the problem of how to run CP/M-based software on the Apple with the Premium Softcard IIe.

On one board, the Premium Softcard IIe combines a Z-80 coprocessor with an 80-column card and 64K of extra RAM. The X-80 coprocessor section of the board contains the circuitry needed to communicate with the Apple IIe I/O bus. This allows you to run CP/M programs as well as Apple DOS programs. The 64K of RAM on the board may be used by either the Z-80 or the 6502 microprocessor. While the 6502 can use the Softcard's RAM and therefore has access to up to 128K, the Z-80 can use only its own 64K of RAM. This is because the Z-80 runs at a higher clock speed than the 6502 and thus requires a higher-speed RAM to function properly. When you are running Apple DOS or Apple Pascal programs, you can command the board to display either 80 or 40 columns on the screen. For CP/M, the Softcard will automatically set up the screen to display 80 columns.

The Softcard's software package includes the CP/M operating system, a *Microsoft BASIC* interpreter and a group of utility programs. The documentation consists of four manuals: three come with the package, and the fourth is mailed to you as soon as you send in the registration card. Both

the documentation and the software are first-class. The only thing wrong with the Premium Softcard IIe is Microsoft's distrust of the consumer; holding back the fourth manual is not going to accomplish anything except annoying the purchaser.

Microsoft Corporation, \$495

PRINTER OPTIMIZER

If your time is valuable, try the Printer Optimizer from Applied Creative Technology, a buffer that allows you to keep on working while your printer does its stuff. The Printer Optimizer is a 64K to 256K printer buffer with a space age panel featuring a 16 push-button keyboard and a three-character LED display. The Optimizer comes with two Centronics-compatible parallel ports and offers as an option an Opticon card, which adds two RS-232C ports to the system.

Putting the Printer Optimizer to work was as easy as reading the instruction manual, one of the best to arrive on the scene in a long time. Organized to perfection and written in plain English, it is easy to find the information you need. The Optimizer is a self-testing unit that has its own transformer and power supply. A second power supply in the form of a lithium battery inside the Optimizer keeps programming information that is stored in the housekeeping memory nonvolatile.

With five modes of operation (100 to 500), this machine is quite versatile. Memory modes 100 to 300 are for printing, character and operating instructions. In mode 400 you can actually print up your operating instructions from the housekeeping memory. In mode 500 you can make up to 99 copies of documents stored in the Optimizer's memory.

If time is money in your computer operation, the Printer Optimizer will save you money. This is a good, low-cost machine that is easy to use. It seems to be free of bugs. Further, since it sits outside of your computer, it gives you the added benefit of remote printing for as many as three printers.

Applied Creative Technology, \$499

PROSTICK II

Newport Controls is a manufacturer of high-quality replacement controls for arcade games. Their first joysticks for the home market were simply rugged arcade game controls put in tough plastic housings. The people from Newport are not ones to let grass grow underfoot and so they have introduced the Prostick II. This second generation joystick comes in three versions: Atari, Coleco, and

Texas Instruments compatible. The testing was conducted on a TI 99/4A.

Compared to the TI joysticks, the Prostick feels solid in the hand. The base is made of molded blue and black plastic that tapers to three inches for a snug fit in the palm of the hand. The Y-adapter, which enables the Prostick to replace the TI joysticks, also doubles as a cable splitter so that two Prosticks may be connected for two-player games. Players will particularly like the switchable gameplate. This is a black plastic collar that fits around the stick. Its function is to lock out directional signals for superior maze gameplay. Once the game plate is switched from eight directions to four, it remains firmly in place. The Prostick also comes with a six-foot cord that is long enough to reach a player's favorite floor cushion or chair. Two responsive firing buttons on the front of the housing round out this excellent joystick.

The Coleco version comes with a Y-adapter to allow the Prostick and Coleco controller to be plugged in simultaneously. The Atari version is identical, but has no adapter.

Newport Controls, price not available

QPAK-68

The Apple II can be converted into a 68000 assembly language development system with the Qpak-68 board and software package. Qpak-68 consists of a plug-in board that runs 68000 programs, an editor/assembler that reads 68000 source code, a debugger and support documentation. The board plugs directly into the Apple and features a 68008 microprocessor, a version of the 68000 that is compatible with 8-bit software. The 68008 is driven by the Apple's clock; this permits it to run parallel with the 6502 in the Apple. The processor can be started, stopped, or interrupted at any time by the Apple.

The Qpak board can run directly out of the Apple's memory. It shares the Apple's 64K memory space and has access to the same memory and peripherals as the Apple's 6502 processor, including the high-resolution display. It comes with 8K of local EPROM and 2K of RAM, expandable to 32K and 8K, respectively. The source code development package, which comes on an Apple-compatible disk, can assemble 68000 programs with up to 8K of object code directly from RAM. Larger programs can be assembled from Apple disks.

This is not a board for beginners, but the Qpak will meet all of the expectations of the professional and of the experienced hobbyist. Some minor conflicts arose in tests run for this review, but nothing

appeared that could compromise the workability of this excellent product.

Qwerty, Inc., \$695

QUAD I/O BOARD

It seems that IBM PC and XT users never have enough interface ports on the back of their computers. Quadram helps solve this problem by freeing several expansion slots with its Quad I/O Board. Quality manufacturing and attention to detail in both its software and its documentation make this board a useful product for a fair price.

The Quad I/O Board combines five of the most popular interface ports on one board for the IBM PC or XT. It contains a Centronics-standard parallel port that can be configured as line printer 1 or line printer 2, two fully programmable RS-232C serial ports, and a game port that supports two joy sticks. A battery-powered clock/calendar is also included.

The Quad I/O Board comes with a software package, *Quadmaster*, that contains programs to set the clock/calendar and to implement the on-board parallel, serial, and game ports. It is completely hardware- and software-compatible with the IBM PC and XT. The documentation supplied by Quadram is both informative and well organized. With the manual to help you install the board, you will be up and running in no time at all.

Quadram Corporation, \$285

QUADBOARD

Quadboard by Quadram is a multipurpose board that performs nine functions while using only one expansion slot in your IBM PC or XT computer. The Quadboard comes complete with a well documented installation manual, software and up to 384K RAM. The board also offers a parallel and a serial port, print spooler and disk cache software, an I/O bracket and a game port.

A handy feature is Qswap, part of the Quadmaster software supplied with the Quadboard. Qswap allows you to change line printer 1 & 2 back and forth as often as you like. Coupled with Master Spool (another Quadmaster program), Qswap makes many kinds of multifunction processing possible. Master Spool provides automatic spooling for both serial and parallel printers—with a twist. This advanced spooler lets you pause at any time as well as back up or move forward in a file. Up to 30 pages of data or text can be buffered without interrupting data processing operations.

Quadboard is advertised as "plug and play," and plug and play is what it does. Good documentation

and a menu drive make installation very easy. Quadboard is compatible with all versions of PC-DOS and once it is installed, you wonder what you did without it. Quadboard is fully warranted for one year, and its hotline seems to answer on the first ring.

Quadram Corp., Quadboard with 384K \$795

QUADCOLOR

Businesses large and small have discovered the many uses of color graphic. When color became available to personal computer graphics, its use soon became a standard tool. Pie charts, bar graphs, and supportive copy are all enhanced by color. Color graphics boards are produced by many computer-related companies. One good board is Quadram's Quadcolor for the IBM PC.

Quadcolor is a piggyback, IBM-plug-compatible board. The package includes *BASICQ*, a software package that modifies *BASICA* graphics commands to use Quadcolor's enhanced features. Offering up to 64K of memory and an amazing 128 colors, Quadcolor is indeed a powerful graphics tool. Its documentation is refreshingly complete, making installation and initial use a snap. Testing in the text mode showed crisp, clear letters. Quadcolor's extra memory allows the text mode to have twice as many active and visual pages as IBM's color graphics adapter allows (16 in 40-column, 8 in 80-column). The graphics mode allows the user to create limited animated displays with two complete pages. Text and graphics overlaying are possible: each video display card in the piggyback set-up has its own memory and its own set of IRGB outputs that can be turned on or off independently. This allows a graphics image to be displayed on one card while text is created on the other, and the two outputs can be mixed to create a single image.

Quadcolor is a complete product offering many more features than the IBM color graphics adapter. It certainly deserves consideration when you are shopping for your system.

Quadram Corporation, price not available

QUADLINK

Imagine using your IBM PC in the office and continuing the same work at home on your Apple. Quadram's Quadlink board allows you to run Apple software on your IBM PC and to transfer your IBM files onto Apple disks. It comes with a 6502 microprocessor, a disk drive controller, 64K RAM, a game port and two disks (a systems disk that loads BIOS and a disk that loads Apple DOS 3.3 and

BASIC). Quadram provides excellent documentation to get you up and running in a hurry.

However, all is not perfect. Beginners will need some help. If you have never run an Apple before, it would be a good idea to buy this board from a local dealer who can provide technical support. Even the experienced user may need a little hand holding. Quadlink's 40-column text display will take some getting used to; it cries for updating to an 80-column display. Not all Apple programs will run with the Quadlink board—Apple drives can read half tracks, but almost all IBM drives cannot. Check with your dealer about this before buying.

Quadram has filled a large gap by developing this link between Apple and the IBM PC. The Quadlink is well thought out from its conception to its comprehensive and thoroughly documented manual. Its advantages far outweigh its shortcomings.

Quadram, \$695

QUICK SHARE

It is always nice to save some money. It is even nicer to get more utility at the same time. Quick Share, from Wolsten's Computer Devices, has done these nice things for Atari 400, 800, or 1200 computer users. Quick Share lets up to four Atari computers share from one to four disk drives, one printer, and one software program.

Quick Share is a small stand-alone device that comes with all the necessary cables and connectors needed to connect four computers, expansion modules, or disk drives together. There is no software support or user programming required. Plugging any combination together and throwing one switch is all that's required to get you going.

Testing proved the Quick Share to be simple to use and problem free. The documentation is skimpy but there is not much to learn before hooking up and using. Its versatility allows many combinations of equipment to be used. You can eliminate the need for three disk drives, three interface modules, and three printers. As an alternative, you can connect up to four disk drives, which will give you access to almost a half megabyte of storage. For the four-computer hookup, one software program will load them all. This is a big convenience for schools. There are no special tools required to set up this product, nor are there any modifications needed on your Atari computer.

Wolsten's Computer Devices Inc., \$595

QUICKLOADER

The Quickloader is a circuit board for Apple II,

II+ and IIe computers that can accept PROMs (programmable read-only memory). The maximum capacity of this board is 256K, but these computer systems can handle more than one card. The Quickloader will accept all of the popular PROMS on the market: 2716, 2732, 2764, 27128, and 27256. The types may be freely mixed on Quickloader. Long programs can take up more than one PROM, and a single PROM may be used to store several short programs. To use this board, you must have access to a PROM programmer.

Once it is up and running, the Quickloader is a joy. Programs can be loaded in fractions of a second. More importantly, DOS is instantly loaded every time the computer is turned on. Because of this, it is not necessary to take up valuable disk space with DOS. This gives the user more than five percent more space for programs and data on disks.

The Quickloader comes with full documentation. FID and COPY utilities are already on the card.

Southern California Research Group, \$179.50

RACOM DATAFINDER

The RACOM Datafinder does fast file searching, text processing, and pattern recognition. It is an S-100 board that runs asynchronously at over 16 MHz. Inward status and outward command are controlled through a single port. All of the 12K on-board status RAM is user-programmable.

The board compares, bit by bit, test data with reference data. It compares only bits that are marked for comparison. The results of these comparisons are recorded in a solution bit. A record may also be compared on a field-to-field basis. You can also do bit and byte offsetting of the test data to be compared.

Datafinder can bring data in from a Winchester disk and then analyze it according to criteria preprogrammed in the Datafinder. Data can be simultaneously written to a number of Datafinders and then concurrently analyzed according to different sets of preprogrammed criteria. Datafinder's status information gives the total number of hits (successful comparisons) and the address of the first hit.

This device will definitely be sought out only by professional computer users. Because it is a product of a British company, it may be hard to find.

RACOM Decision Systems Division, £850 British

RAINBO-256

There are many reasons for wanting your Apple II to display color graphics. The Rainbo-256 from Microtek can do this and much more.

The Rainbo-256 is a high-resolution RGB analog driver that is plug compatible with the Apple II. It comes supplied with a software package called *Paint Brush*. The *Paint Brush* is a user-friendly program that allows even the novice computer user to change the colors of displays.

The Apple II is normally capable of producing only 16 colors on a monitor. The Rainbo-256 allows the Apple to produce 256 discrete, programmable colors. In testing on three different monitors (Amdek, Electrohome, and Taxan) in the Apple high-resolution mode, text displays were pure white when displayed alongside the color graphics: none of the color fringing usually associated with text on an Apple occurred. The Rainbo provides the standard Apple colors automatically when the computer is turned on. All additional colors and the user's ability to customize them are software-controlled.

The documentation supplied with the Rainbo-256 was adequate for installation and for running the software. There are no unpleasant surprises with this quality product. In tests run for this review, everything worked the first time it was tried, and the product was truly user friendly.

Microtek, Inc., \$149

RAM DISK

With the help of innovative companies such as Axlon, the Atari 800 is entering the realm of small business computers. Axlon manufactures the RAM Disk, a memory board that provides 128K of RAM to the Atari. Designed to operate with either two 16K RAM boards or one 16K and one 8K board, the device is organized into eight 16K segments. It may be used to increase the RAM address space to a maximum 160K.

The RAM Disk, operating in conjunction with the supplied memory-management software, can be used as a disk emulator. This software is fully compatible with existing Atari 800 software, and, when the system is booted up, the RAM disk is assigned as drive 4. This feature is useful for long, time-consuming applications such as processing mailing lists and reproducing disks.

Since the RAM Disk may be used as eight separate 16K byte segments that all occupy the same memory address, its most innovative use would be for animated graphics. By switching from one memory segment to another, you allow immediate transition from one screen display to another. This bank switching is much faster than the results you get from altering the Atari display list to obtain the screen information from a different location. Even more spectacular effects can be created by chang-

ing from memory bank to memory bank in the middle of a screen.

The RAM Disk is enclosed in a plastic case similar to that of an Atari module, but there the similarity ends. Using less power and producing less heat than two 16K RAM boards, it is an attractive option for Atari 800 users.

Axlon, Inc., \$299

RB5X

RB5X is an intelligent robot that detects and responds to objects in its path. It comes with 8K of memory, programs and tactile sensors. Once RB5X makes a successful response to an object, it remembers its actions and repeats the correct response when confronted with the same situation later.

For program entry and data transfers, RB5X is supplied with an RS-232C serial port. This makes it compatible with such microcomputers as the Apple, the Radio Shack TRS-80 and the IBM Personal Computer. This port lets you transfer RB5X's memory to your computer, where you can then study and alter its patterns and programs.

RB5X is equipped with a circuit that automatically charges its batteries. Other standard features include a sonar sensor and a pulsating light. It has an aluminum body with a polycarbonate dome, and it measures 13 by 24 inches. RB5X weighs ten pounds and uses two rechargeable six-volt gelled electrolyte batteries, which are included.

Options include 16K bytes of additional memory, data telemetry and a mechanical arm. A voice recognition system and a speech synthesizer are being developed.

Although it is a novelty, RB5X is not a toy. This is certainly reflected in its price. It is capable of very sophisticated actions and some practical uses.

RB Robot Corporation, \$2,225; mechanical arm \$1,495; speech synthesizer \$245; additional 16K RAM \$195; RCL 2 (voice recognition) \$595

RBS-AC RESERVE BATTERY SUPPLY (AC OUTPUT)

The RBS-AC Reserve Battery Supply provides backup power to computers, peripherals, or other electronics during power failures or low-voltage conditions. The 300VA model supports 300 watts of connected equipment for at least 9 minutes or 75 watts for 65 minutes or longer. The 500VA model powers 500 watts for at least 9 minutes or 150 watts for 48 minutes.

Installed in the AC power line, complete systems

with computer, printer, terminal, modem, and so on, are kept on line during power interruptions.

The RBS-AC is a "switching" reserve or standby supply, not a true uninterruptible power supply or UPS. Switchover to battery backup is within 5 milliseconds of power failure—fast enough to accommodate even sensitive electronics.

The output is a "rectangular waveform," which may adversely affect a few computers whose internal power supplies demand sine-wave power (only one such system was found). The waveform may slow AC motors such as cooling fans. Unless the system tends to overheat, decreased cooling should not be a problem. Motor slowdowns may adversely affect AC-driven 8-inch disk drives or hard disks, so the unit should be used only with DC-driven drives powered by the computers.

The RBS-AC provides voltage regulation, surge and spike suppression, noise protection, and audible and visual alarms. It prevents excessive battery discharge, and recharges within 10 to 12 hours of a "deep" discharge.

Control Technology, Inc., 300VA \$569; 500VA \$695

RBS-DC RESERVE BATTERY SUPPLY (DC OUTPUT)

The RBS-DC is a reserve battery supply that taps internal microcomputer power supplies. Models are available for the Apple II, II+, IIe, and III, IBM PC, Franklin Ace 1000, 1200, and Basis computers.

An adapter is interposed between the computer power supply and the electronics. On an Apple, that adapter replaces the normal motherboard connection from the internal power supply. Through the adapter, the RBS-DC bleeds off DC current to charge its batteries and provides DC current back to the electronics when normal power fails.

The unit supports only devices powered from the computer's internal power supply, such as plug-in cards and DC-driven floppy disks. It cannot power an external monitor, CRT, printer, buffer, or similar device. The RBS-DC has a long "holdup time," supporting a moderately loaded Apple II+ for about 115 minutes (just under two hours)—more than enough to get through most short-term power failures.

There is switchover time between power failure and battery takeover, but RBS-DC units switch well within tolerances of computers for which they are designed.

Recovery from deep battery discharge takes less than 24 computer-on hours. The unit has both audible and visual alarms, and an option is available to connect it to an external 12-volt DC source, such as an auto battery or cigarette lighter, for extended

runtime. Transient suppression (for surges and spikes) is available as an option.

Requirements: Apple II, II+, IIe, and III; IBM PC; Franklin Ace 1000-1200; Basis Control Technology, \$325; \$375 with transient suppression

RGB-80 INTERFACE BOARD

The Princeton Graphic Systems HX-12 color monitor, a state-of-the-art RGB unit designed to go with the IBM Personal Computer, can now also be used with the Apple IIe. All that's needed to make the HX-12 compatible with the IIe is a new interface board, the RGB-80, manufactured by PGS.

The PGS RGB-80 card has a double purpose—it not only serves as an Apple IIe/HX-12 interface card, it also provides full 80-column text capabilities to an Apple IIe. When the card is plugged into one of the peripheral slots inside an Apple IIe, the PGS HX-12 can be used to display any program that is run on the computer, with either a 40-column or an 80-column display. No separate card is needed to provide the computer with 80-column capability.

When an HX-12 monitor is connected to an Apple IIe by a PGS RGB-80 card, three graphics modes are available: low resolution, medium resolution, and high resolution. The low-and medium-resolution modes support 16 colors each, and 6 colors are available in the high-resolution mode. All three modes allow the user to mix text and graphics on the screen. According to the PGS, the RGB-80 card improves the video quality of the Apple IIe by removing the extraneous colors that occur during color transitions in the computer's low-resolution mode and mixed graphics modes. When a monochrome display is desired, four default text colors are available: green, blue, amber, and white.

Princeton Graphic Systems, \$185

ROBOGRAPHICS CAD-1

The Robographics CAD-1 is the most advanced drafting system available for the Apple II-series computers. Manufactured by Chessell-Robocom, it provides technical drafting capabilities that rival computer-assisted design systems costing tens of thousands of dollars.

The standard peripheral used for input with the CAD-1 is a precision joystick module. It includes a high quality joystick, a disk-type potentiometer, and three push buttons. The CAD-1 plugs into the existing game I/O socket on the Apple, which must be equipped with a minimum of 64K bytes of RAM

and two disk drives. The controller is solid and heavy, and has a feel that sets it apart from any other Apple joystick one may be tempted to compare it with.

The main graphics program is menu-driven. When the program is loaded, the screen comes up with the menu showing text down the right hand side and graphics across the bottom. If the user chooses the selection "Menu," a second menu of choices appears down the right side of the screen. This sequence of nested menus makes the operation of the CAD-1 system very simple.

Other features that lend remarkable power to the CAD-1 are the library disk and the zoom capability. The library disk contains a graphic index of miniature drawings, any of which can be obtained, scaled, and modified to use with the original drawings. The zoom feature allows detail to be added to a specific area of a larger drawing. You then return to the original base page scale.

While not inexpensive, this well-documented system gives the user a professional drafting capability that is unsurpassed by many systems costing much more.

Chessell-Robocom Corporation, \$1,095

SANDSTAR MODULAR MULTIFUNCTION CARD

SANDSTAR is a modular system that provides multiple functions in a single expansion slot of an IBM PC, IBM XT or IBM-compatible computer. The user purchases only the options he or she needs, and various option modules can be removed from or added to the basic SANDSTAR card at any time.

The basic card holds 256K of RAM that may be assigned with jumper wires and internal computer switches. An additional memory module can add up to 320K more memory, although some of the IBM-compatibles may not be able to use this much memory.

The board will accommodate up to three of the following option modules at a time: parallel interface, RS-232C serial interface, battery-operated clock/calendar and game adapter. Other modules are being developed. The serial and parallel interfaces may be assigned to COM1, COM2, LPT1, LPT2 and LPT3.

SANDSTAR's supporting software includes a program to set the clock/calendar, reading programs and a STARDISK program. STARDISK allows the user to set up one or more high-speed memory disks in size(s) of his or her choice (160K and 320K are recommended for their compatibility

with physical disk drives). The best STARDISK performance is achieved with PC DOS.

Although SANDSTAR's software does not include memory diagnostics or printer spooling, programs obtained elsewhere will often work with the system.

Maynard Electronics, Modular memory card with 256K RAM \$399; with 128K RAM \$218; Parallel port module \$47; Serial port module \$76; Game adapter module \$39; Clock/calendar module \$44

SATURN MULTIFUNCTION CARD

Most multifunction boards for the IBM Personal Computer are built to very similar standards. What sets one apart most often is the software that comes with it. Saturn Systems has created a multifunction board that is accompanied by some truly fine software.

The Saturn Card is a standard expansion board that fits into any slot on the IBM motherboard. The card combines two serial ports (COM 1 and COM 2), one parallel printer port, a clock/calendar with battery backup, up to 576K bytes of RAM, and a new twist—a hard-disk interface. The software package includes *Pseudo-Disk*, a fast RAM disk emulator; *Pseudo-Print*, a print spooler that allows simultaneous printing and processing; a hard-disk support program using the SASI interface on the card; and a support program for the clock/calendar, which eliminates typing in the system date and time during system start-up.

Installation and use are made easy with the very good hardware and software manuals that are provided. They offer step-by-step instructions that are well organized and clearly written. As a convenience, the manuals will fit in the IBM system binders. The Saturn Card works exceedingly well and the software is a dream come true. Programs that require a lot of disk access run much faster and quieter with the disk emulation feature. The user-defined amount of RAM that can be set aside for print spooling makes all but book-size printing projects an easy one-step project. You just keep on processing while the printer does its stuff. Testing was not done on the hard-disk interface, but from all indications it should run as well as the rest of the system. The Saturn software package requires an IBM PC with at least 64K bytes of memory, one floppy-disk drive, and the PC-DOS operating system.

Saturn Systems Inc., \$795

SAYBROOK

An increasing number of Apple users have reached the limits of their machine's capabilities. These users face a dilemma—to buy a new system or not. Saybrook, manufactured by Analytical Engines, presents another alternative.

Saybrook is a 68000 coprocessor board for the Apple II. The Board comes with 128K RAM expandable to 512K. Off-board expansion to 16 megabytes, a clock/calendar, and an operating system timer (which can allow the Apple to handle multiple users) are also available as options.

A large package of software is included with this integrated board: USCD p-System IV.1, FORTRAN 77 and BASIC compilers, and Applesoft-compatible 68000 BASIC. As an additional option, you can get a p-System application package that includes a spreadsheet from Timberline and a word processor by TICOM. Forth, CP/M-86, and Unix are also available.

The MC 68000 is a 32/16-bit microprocessor capable of running programs 10 to 30 times faster than the 6502 in your Apple. Two clock speeds available (8 MHz and 12.5 MHz), and, of course, the clock speed and software used will determine just how fast your programs run.

The documentation supplied with the Saybrook is a joy—clear and concise, it makes installation a simple step-by-step operation. The software instruction manual is just as good; however, this is not a product for a computer novice. Successful use of Saybrook requires a well-rounded background in computer operations. Analytical Engines includes a free membership in the Saybrook Users Club with the package.

Analytical Engines, Inc., 128K RAM \$1,550; 512K RAM \$1,950

SCORPION

The Scorpion, from Rhino Robots, is a compact software-programmable robot that makes noises as it trundles across your floor. Shipped only in kit form with complete assembly and programming instructions, it is the cheapest robot around.

Scorpion's base measures 9 inches by 12 inches. It is equipped with a 6502 microprocessor, an 8K EPROM, 2K of RAM and two 6522 interface chips that provide 32 I/O lines and four programmable timers, two of which can be event counters. Its eight microswitches discern obstacles in its way and allow it to avoid those obstacles by retracing a preset path. A two-axis optical scanner with a resolution of 1.5 degrees of scan per step recognizes

patterns over a 300 degree span in both horizontal and vertical planes. These patterns can be displayed on your computer's video monitor. Additional hardware includes sensing bumpers, a speaker, two ground tracks, two "eyes" and four monitors, two of which are drive wheels. Scorpion works with any computer that has an RS-232C interface. It operates from a 12-volt DC power supply.

The Scorpion looks like a toy and acts like a toy, but under its rather funny-looking surface beats a sophisticated heart. With Scorpion, you can devise your own artificial intelligence experiments; it is extremely useful in many kinds of experiments that normally require much more expensive equipment. Its one flaw is its documentation, which could be vastly improved.

Rhino Robots, Inc., \$660

SEMI-DISK

The Semi-Disk disk emulator from SemiDisk Systems frees your computer from being tied down to the speed of your disk drives. It allows your computer to run many times faster than it does now. Semi-Disk consists of a high-capacity memory board, driver software, and a poorly written user's manual. The board comes in standard sizes for S-100, Radio Shack II, and IBM computers.

All of the testing for this review was done on an IBM PC. The installation of the board was not difficult, even though the manual doesn't spell out installation instructions or even show a picture. Running the supplied software program confirmed that Semi-Disk had added a virtual disk drive to the system.

You don't realize the speed that your IBM is capable of until you use a disk emulator. With Semi-Disk, normally disks-intensive operations like full file sorts take seconds instead of minutes of execution time. The Semi-Disk can operate on a battery back-up. Because of Semi-Disk's low power consumption, it is easy to provide this protection, and provisions for it have been made on the board. Poor documentation notwithstanding, this is a fine product. It is expandable from 256K to one megabyte per board, and up to eight boards can be added to your system.

SemiDisk Systems, \$995 to \$2,350

SHARENET X

Sharenet X is a local area network system that uses the IBM XT or the IBM PC with an extension chassis containing a hard disk as the file server. It can support up to three printers, one parallel and two serial, and can manage a total of 320 mega-

bytes of shared disk space. This means up to 255 users can be handled at one time, but 25 to 50 would be more feasible.

The SHARENET X interface board is called a Network Interface module and consists of a 6 MHz Z-80B microprocessor and 64K RAM. SHARENET X uses no DMA channels or hardware interrupts; instead, the 64K RAM on the interface module becomes addressable by the 8088 microprocessor on the IBM motherboard and is used as dual ported memory for packet transmission and for holding the software. SHARENET X requires at least 256K RAM in the file server. It communicates directly with the fixed disk controller, bypassing all ROM-BIOS fixed disk function calls. Because of this, SHARENET X must use an IBM fixed disk. The IBM controller is proprietary and other disks claiming PC-DOS 2.0 compatibility will not work.

SHARENET X performs very well in day-to-day operations. The software is easy to use and the system is not very difficult to install. It provides true file and record locking features. The one drawback is that the system limits the user to one type of equipment. If a better or larger or less expensive hard disk becomes available from someone other than IBM, it cannot be used with SHARENET X.

Novell, Starter set \$2,900

SHUFFLEBUFFER

The ShuffleBuffer is a print buffer with several features that are out of the ordinary. As a stand-alone unit, with its own power supply, it can be moved between multiple computer systems. If you have more than one computer, as a growing number of us do, this feature is an advantage over the dedicated plug-in-board type of buffer.

The second major feature of this unit is its ability to accept input from either a serial or parallel interface and output either to a serial or parallel printer. The unit can even be used as a mode-converter which accepts input from a computer's parallel interface and outputs it to a serial printer (or vice versa). If you have both parallel dot-matrix and letter-quality serial printers, this feature can be quite attractive.

ShuffleBuffer's one great advantage over other print buffers is what the manufacturer calls RAP—Random Access Printing. RAP allows you to define "buckets," individual areas in the buffer's memory. Documents, graphs, spreadsheets, and the like are loaded into various individual "buckets" and are printed out in any sequence you specify. This permits you to combine graphics and spreadsheets into the body of a piece of text. The ShuffleBuffer also permits you to print multiple copies of a docu-

ment or even emulate a "Mail-Merge" capability, storing a form letter in its memory and merging a computer transmitted list of names into it.

This capability does not come without a price. The ShuffleBuffer is not particularly difficult to use, but it is not especially easy to configure. The set-up process requires that you have a fairly good idea of the particular hardware interfacing protocols used by both your computer and printer. If you have this background, and the documentation for your computer and printer is fairly complete, you should not have much difficulty in setting up the ShuffleBuffer. If you are lacking in experience and/or documentation, be prepared to spend some time experimenting with various combinations of the DIP switches and jumpers.

Interactive Structures, ShuffleBuffer (32K) \$349; (128K) \$499

SINGLE-BOARD EQ-4

The Single-Board EQ-4 from Insight Enterprises is a computer kit that's compatible with CP/M 2.2 and 3.0. It has virtual-memory mapping circuitry that gives its Z-80A processor direct access to 128K of RAM, 2K of EPROM, and 4K of video memory in 8K blocks.

The EQ-4's interfaces include SASI, four serial RS-232C channels (whose independently programmable data rates range from 110 to 76,800 bps), a Centronics parallel printer port and floppy disk drive ports. The floppy disk controls can handle single- and double-density 5¼-inch and 8-inch drives simultaneously. CTC, DART and PIO peripheral controllers are standard. The parallel keyboard input can accommodate a 7-bit or an 8-bit ASCII board. EQ-4's video features are horizontal and vertical sync signals and composite video output. The board's on-chip character generator supports 128 characters in 7 by 11 dot matrices, character-oriented wide- and thin-line graphics, reverse video, and character blanking, blinking, underlining, and strike-through.

This unit is not for the inexperienced. The average user will need some training to be able to successfully assemble the EQ-4 into a working computer.

Insight Enterprises Corp., \$750

SIX PAK PLUS

A popular multifunction board for the IBM PC, the Six Pak Plus offers the usual array of features associated with this type of board. One of the first boards of its kind, the Six Pak Plus works with the

original IBM 64K system board as well as with the newer 256K PC board and the XT.

The Six Pak Plus board consists of RAM memory starting at 64K bytes (expandable in 64K increments to a total of 384K) one serial port, one parallel port, a clock/calendar with battery backup, an optional game port, and two excellent software programs. *Superspool*, a powerful buffer program for your printer, allows you to work on a separate task while your printer works away on its own. *Superdrive* is a disk emulator program; it allows you to set aside some memory for use as a super fast virtual disk drive. Both software programs are compatible with both DOS 1.1 and DOS 2.0.

The documentation supplied with the Six Pak Plus is very well done; it is complete, accurate, and easily understandable. With its help, the system can be up and running quickly. After several days of testing, Six Pak Plus appeared to be free of bugs and caused no problems running on an IBM XT.

AST Research, Inc., 256K \$695; 384K with game port \$970

SLOT SAVER KIT

The absolutely least expensive and simplest way to expand your IBM PC beyond its original five expansion slots is with the Slot Saver Kit from TAMAC Electronics. The Slot Saver allows two circuit boards to be plugged into each of the five slots on the IBM PC motherboard. Its price is an amazing \$12.95. The only tools required for its installation are a soldering iron, a screwdriver, and a toothpick.

An IBM expansion board has a row of metal-lined holes along its bottom edge. These holes are used to connect the printed circuits on one side of the board to those on the other. They also connect to the gold-plated contact pins that plug the board into a motherboard slot. Those contacts are what the IBM system looks at to determine what kind of expansion peripheral you have in place—and that is the key to the Slot Saver's approach.

The Slot Saver Kit includes 62-pin male and female connectors, a nylon spacer with two 4-40 × .25-inch screws, toothpicks to help you push the old solder out of the holes and new solder to hold the connectors in place. Easy-to-follow installation instructions are also included.

It works, it is easy to install, and it is inexpensive—not a bad combination in a high-priced, high-technology world. Before you try this system on any other board, though, beware: it only works with IBM boards.

TAMAC Electronics, \$12.95

SOFTBOX

In the early days of microcomputers, the problem of incompatibility was addressed, and CP/M was born. CP/M is popular because all hardware-dependent parts of it are put in one part of the program. A developer can change just those portions of CP/M involving specific hardware, without touching the main application.

Commodore, choosing to march to a different drummer, did not meet the requirements for CP/M with their PET or CBM personal computers. However, Small Systems Engineering, Ltd., has overcome Commodore's stubbornness by developing the Softbox, a stand-alone device that solves the compatibility problem once and for all.

The Softbox is attached via a standard PET interface cable daisy-chained off any peripheral. A power cord goes to an AC outlet, and that's it. Softbox has three indicators on the front panel for power and the disk drive in operation. Internally, it contains a Z-80 microprocessor and an additional 64K bytes of RAM. Available options include an RS-232 interface and the hardware necessary to hook up a Corvus hard disk drive.

The Softbox is a nice package. It is easy to install and avoids any heat problems by virtue of its stand-alone design. What's more, it works.

Small Systems Engineering, Ltd., price not available

SOLA MINI-UPS 750VA UNINTERRUPTIBLE POWER SUPPLY

As a true uninterruptible power supply, the Sola Mini-UPS supports entire microcomputer or mini-computer systems through short-term blackouts, brownouts, and other periods of irregular power. Connected equipment is powered by a battery-driven inverter at all times, with AC line power only keeping the batteries charged. There's no switch-over time after a power failure, so even sensitive equipment is unaffected. Equipment isolation from the AC line and extensive line conditioning provide immunity to surges, spikes, electrical noise, and other power problems.

Typical support times for the 750VA model range from about 10 minutes for a full load to more than 80 minutes for a 100 watt load. Auxiliary battery packs can increase that to as much as two hours for a maximum load. Recovery to 95 percent of capacity from a "deep" discharge can be accomplished in two hours or less.

Mini-UPS output is a true sine wave, rather than a rectangular waveform. It does not affect equipment sensitive to waveform and demonstrates no

tendency to slow AC motors. The Mini-UPS does not reduce cooling fan efficiency or interfere with AC-driven 8-inch floppy disk drives or hard disks.

Though more expensive than switching standby supplies, this unit can handle critical installations in which continued operation and absolute data integrity must be maintained.

Sola Electric, \$1,808

SPECTRA VIDEO QUICK SHOT

One of the nice things about owning an Atari home computer is the wealth of games that are available for it. Of course, to play games properly you need a good joystick. One of the best around is the Quick Shot from Spectra Video. The Quick Shot has a fully contoured hand grip. For games like Star Raiders you can wrap your whole hand around it and fire away with the button on top of the stick. But for games like Shamus that require a more sensitive touch, you can grip the top of the handle like a normal joystick and use the firing button in the base housing. Actually, you will find yourself going back and forth, using both the firing button in the handle and the one in the base.

The firing button in the base is normally at the top left corner of the housing, favoring right-handers who control the stick with their right hand but fire with their left. However, a unique design allows the handle to be rotated 90 degrees which puts the button at the top right for left-handers. Quick Shot comes with four removable suction cups that fit in the housing and fasten the unit firmly to a desk or table. An extra-long cable is provided so that players need not be crawling over one another to get close to the computer or game system. This is easily one of the best joysticks on the market.

Spectra Video, \$12.95

SPECTRUM STICK

Color Computer owners, have you been looking enviously at the many high quality joysticks available for the Apple? Has the dimpled contact in the Color Computer joystick button come to the end of its short life? Do you yearn for a joystick with precision? If you answered yes, the Spectrum Stick may be for you.

This rather large 6 x 3 x 2 inch unit is more than twice the size of the Radio Shack original equipment Color Computer joystick. However, the blue plastic case houses a joystick with real potentiometers, a heavy duty pushbutton, and an LED indicator that shows whether the power is on or off. The size lends itself to both hand-held and tabletop

use. The central placement of the firing button makes it suitable for both left- and right-handed players. Both the joystick handle and the pushbutton are considerably stiffer than Tandy's. However, some users will prefer the extra pressure required in the Tandy original and consider it an aid in control.

Spectrum Products, \$39.95

SPEECH COMMAND SYSTEM

Every computer manufacturer has its own idea of what makes a computer easier to use. Some think a mouse and windows are the answer; others like menu-driven operating system shells; still others claim touch-sensitive screens are the greatest thing since sliced bread. Texas Instruments is into speech.

Thanks to Texas Instruments, your computer can now not only talk, but listen. The Speech Command System (SCS) is a package of hardware and software that lets your TI Professional Computer accept spoken commands and double as a telephone dialing and answering machine, a dictating machine, and a talking calendar.

The SCS hardware comprises two tightly packed, piggyback circuit boards that go in one of the TI Professional's slots; a lightweight headset; a telephone connection cable; a diagnostic disk; and a hardware manual. Quite a bit of software comes with the SCS, too. The stuff that lets you control the computer with spoken commands is called the Transparent Keyboard or TPK for short. The TPK responds to certain words and sends the computer characters or commands as if they were typed.

The Speech Command System is a unique product. With its phone-answering, dialing and directory features, it's best suited for somebody who works with telephones a lot. You can certainly get separate machines to do most of the things SCS can do, but it's nice to have all the features in one package.

Texas Instruments, \$2,600

SPOOL Z-Q 100

Spool-Z-Q 100 is an S-100 (IEEE 696) compatible 256K character hardware printer buffer. It interfaces to both serial and parallel printers as well as combining many other desirable features and capabilities. JVB Electronics offers the board with from 32K to 256K, or you can buy a bare board and expand it to the 256K maximum by plugging in standard 4164, 64K RAM chips. Sockets for the full 256K are installed on the board.

The Spool-Z-Q 100 interfaces to most printers. Baud rates, parity and word length are switch-selectable for the serial interface. The board supports several protocols, including XON/XOFF, ETX/ACK, ENG/ACK, and reverse channel in either polarity. The system's on-board processor frees your computer and shrinks your BIOS. It also ignores the reset signals on the S-100 bus (although they may be jumper enabled) so that even if your computer has a program crash, Spool-Z-Q 100 will continue printing queued documents.

JVB Electronics offers a nice touch by providing a socket for an optional switch panel that allows you to control the copy, clear the buffer and self-test the functions. Also, two modes, normal and pause on feed, allow for both normal and special buffered printing. The Spool-Z-Q 100 should be a welcome addition to any S-100 based system. It is a quality-built, powerful and well-thought-out system that provides true usefulness to heavy printer users.

JVB Electronics, \$319 to \$529

SPRINTER II

Do you own a Radio Shack TRS-80 model I or III, and are you thinking of getting a faster machine? Holmes Engineering's Sprinter II is an accelerator board that will increase the speed of your TRS-80 up to three times. The Sprinter II offers 16 different speeds. All are integer multiples or dividends of the computer's standard 1.77 MHz clock speed, and the highest speed available is 5.3.

Installation is easy. Remove the Z-80 chip from the TRS-80 motherboard, and plug in the Z-80B microprocessor contained in the Sprinter II. Four wires must be attached, then the job is over. The clock speed is controlled by software, and you are permitted to slow it down as well as to speed it up.

Some TRS-80 models will not run at the fast 5.3 MHz clock speed. Early models were produced with RAM chips that run at 450 ns instead of at the current standards of 200 ns or 150 ns. The engineers at Holmes have figured out a simple solution to this problem that can be implemented by the user; however, they recommend that you send your unit to them. The fix costs about \$75, including shipping costs.

The instruction manual supplied with the Sprinter II is a happy surprise. It is clear, it is concise, and it even has photographs that help to explain the text. Included is a trouble-shooting guide that describes common problems and their solutions.

The Sprinter II offers a lot for a small price. While

the system is not without its faults, they are correctable. The people at Holmes Engineering are not only sympathetic to users with these problems, they are also most willing to help.

Holmes Engineering, \$99

SPS-0200 RESERVE POWER SUPPLY

The in-line SPS-0200 Standby Power Supply supports 200 watts of connected equipment for approximately 20 minutes. The output is a rectangular waveform, not a true sine wave, and it does tend to slow AC motors such as 8-inch disk drives and cooling fans. Therefore, the SPS-0200 is best suited to computer systems having DC-driven minifloppies or microfloppies and convection cooling.

As a standby supply, the unit has to switch from line to battery backup on detecting a power failure. Such switching is supposed to occur in less than 10 milliseconds, but the delay has been long enough to occasionally shut down two of five test systems and, a few times, it has blanked a video screen even when the computer remained operational.

A built-in delay of several seconds between power restoration and switching from battery to line prevents "chattering" during typically erratic AC power return. A suppression network guards against potentially damaging powerline transients such as surges and spikes.

There is no provision for adding external batteries, so backup time is limited to that provided by internal gelled lead-acid batteries. There is a companion SPS-0400 unit capable of supplying 400 watts, but it's rated at only 8 minutes of holdup time under full load. Audible and visual alarms are provided. Recharging the SPS-0200 from a "deep" discharge takes 12 to 16 hours.

SAFT-America, \$489

SUPER CHAMP REMOTE

Over the years there has been a steady evolution in joystick controllers as manufacturers learn from the mistakes of their predecessors and respond to the desires of the market. One highly evolved product is the Super Champ Remote from Championship Electronics. The Super Champ Remote is a tall stick that is remarkably sensitive to the touch. It only requires a tad over 1/4-inch movement at the top of the 5-inch handle to activate the contacts. With two firing buttons in the handle, one on the top and one in the front, it is one of the best Atari-compatible joysticks around.

To achieve the remote configuration, Champion-

ship Electronics housed a miniature transmitter in the base of the joystick. This fits nicely in the space that previously was occupied by the ten-foot cord and wind-up mechanism in their original version. A receiver unit is located near and plugged into the computer. Now you can sit across the room or move about while playing your favorite game. You will still have to get up to activate the switches on the game console or computer to start a new game and to select options and skill levels. But the rest of the time, you are free to move where you wish. The Super Champ Remote is a new idea that works very well.

Championship Electronics, price not available

THE SUPER COMPUPRISM

The Super Compuprism graphics board from J.E.S. Graphics is an S-100 graphics board whose S-100 signals do not conform to the IEEE/696 specifications. It has a 288 x 192 x 4 matrix display, with each pixel in the 288 x 192 plane capable of being assigned any of 16 grey levels or 16 colors. The board contains 32K of dynamic memory.

First the nice things about this graphics board. The Super Compuprism has a resolution of 288 x 192 vertical pixels. This is relatively high for micro-computer-based graphics boards. Sixteen grey levels or colors (switch selectable) can be produced by the board, and each pixel can be independently set. The graphics display is easy to manipulate, and the subroutines that write to the board are straightforward.

Now for the worst. The kindest word that can be applied to the documentation is inadequate. The instructions are pages of photocopies stapled together. At one time, all of the documentation had been typed, but subsequent revisions are handwritten, with occasional scribbles on at least half the pages. The memory store and fetch times on this board are quite slow, perhaps four times as long as the time of a normal memory board. Finally, reliability and ease of maintenance are poor. The board had frequent and continuous burnouts that proved difficult to reach and repair. In its present form, with the problems encountered, this board cannot be recommended to the general user. Hardware hackers may be able to resolve the difficulties, and might consider this board for its inexpensive graphics capability.

J.E.S. Graphics, \$395

SUPER FAN II

The most important and least purchased peripherals for the Apple II series of computers are prob-

ably a fan and a surge protector. Most Apple users would prefer to spend their money on a new expansion board, a new game, or other software. The Super Fan II with Zener ray protection from the people at R.H. Electronics is a compact combination unit that sits along the left side of the the Apple computer, hooking into the side vents. Surge protection is accomplished in two stages. The first stage protects against such things as lightning surges and discharges of stored electricity in reactive circuits. The second stage is a high-speed section. It will clamp 20 to 100 times faster than the Apple system, providing an additional 1500 watts of surge protection. Line power filtering is also supplied.

R.H. Electronics includes an air-flow seal kit for those using their device on the Apple monitor stand. The foam rubber padding and brackets are a necessity for monitor stand use. The fan is a little noisy but liveable. Using the foam rubber padding from the seal kit helps to dampen the vibration whether you are using the monitor stand or not. If your Apple is stuffed with peripheral cards and living in an unfriendly environment such as a basement, den, or anywhere near a heat source, Super Fan II is good insurance.

R.H. Electronics, price not available

SUPERCOLOR BOARD

The Supercolor Board from Electrohome Limited allows the Apple II to drive a professional color video monitor. The board sends three separate signals that directly control the amounts of red, green, and blue that appear on the monitor's screen. Without this board, the three signals would be combined with several others into a single composite video signal that would then be decoded by a television receiver. By eliminating the combining and decoding steps, Supercolor Board facilitates an extremely clear, high-resolution display.

No modification of your Apple II is required. The board easily fits into slot 7 on the Apple motherboard. Unlike some other video boards that use extra memory in the Apple II, the Supercolor Board uses only the memory assigned to slot 7. It therefore does not interfere with normal Apple II functions.

The board adds 16 new memory locations to the Apple II. The contents of these locations determine low-resolution graphics colors and high-resolution colors. These can be altered by using the *Colorset* program provided in the board's software package. Although the board will work with any RGB monitor, it offers 256 colors only to analog input monitors.

A 5¼-inch floppy included in the package contains demonstration testing and color programming software. Because this disk is not copy-protected, the user can easily customize this software. The color output from this package is clean, and pure white text is available in the high-resolution mode. This is an excellent board that comes fully supported.

Electrohome Limited, \$249

SUPERMOTHER

It seems old computers never die. There is almost always an outside vendor that comes up with a better idea to expand the geriatric machines' uses, and extend their lifespan. Compuscope has just given new life to Commodore's VIC-20 personal computer by designing an expansion board that will allow VIC-20 users to add function and performance to their computers inexpensively. This great new product is called Supermother.

Supermother is so easy to install that even the non-computer user can do it. Simply plug it into the rear cartridge interface on the VIC-20 and go to work. It is fully buffered to ensure accurate data transmission from the board to the VIC-20. The board's features include eight switch-selectable cartridge slots, up to 35K bytes of additional RAM, a system reset button, a write protection switch, and a replaceable power fuse. A unique addition is a pause button that allows the user to stop a program in progress and start it up again upon command.

The Supermother was found to be trouble-free. What's more, several of the new tools it offered were of the kind that makes you say, "How did I ever get along without it?" For instance, the write-protection switch, when used with the *Blocksave* software (which is included), lets you make copies of cartridge programs on tape or disk. And the system reset button certainly eliminates wear and tear on the VIC-20. Supermother resets the computer at the touch of a button. How did they do all this at such a low price?

Compuscope, \$129

SUPER-PRO REPLACEMENT KEYBOARD

The Super-Pro Replacement Keyboard from Mark Data Products replaces the TRS-80 Color Computer's keyboard. This kit comes with a plastic dress panel that is designed and colored to complement the system. In addition to looking better with this well-fitted keyboard installed, the Color Computer also performs better: The board's key contacts are solid and its response is very good.

Installation could not be easier. After removing the computer lid, remove the original keyboard by detaching a small cable, clip off the top portion of an unneeded support post, place the new keyboard in position, secure the dress panel on the computer lid, and screw everything back together. For newer model Color Computers, a special plug adapter is required. You do nothing to alter your computer in any way, and you can replace your original keyboard at any time.

The keyboard arrives carefully packed with a single sheet of instructions. With most products, one page of documentation would be ridiculously insufficient, but in this case it does the job. The detailed instructions are numbered for step-by-step reference. Although no illustrations are provided, each instruction is spelled out quite clearly. This product is a good buy.

Mark Data Products, \$69.95

SUPERTALKER II

With the Supertalker II, from Mountain computer, you can enter segments of speech into an IBM PC or PC-compatible, save them on disk, then play them back in any order. The Supertalker II is a standard-size IBM printed circuit board that fits into any expansion slot. The package includes a microphone, a cable, a loudspeaker, speech processing software on disk and an operations manual.

The circuit board, under program control, converts audio input into digital form and digital into audio. Microphone input is converted into a stream of bytes that can be saved by the program and later used to produce the original sound through a loudspeaker. The circuit board includes 32K of RAM that is available as standard memory (not limited to speech applications).

The software records, saves, and plays back sound in units called phrases. Phrases are grouped into larger units called phrase tables, which may be up to 44,500 bytes long. Each table may contain many phrases, but the duration of the speech contained in each phrase table is limited. This limit varies from 10 to 70 seconds, depending on the kinds of words used.

The operations manual is well-illustrated and clearly written, but it does not cover every eventuality. One gap: set-up instructions are not supplied for systems with more than 224K of RAM. In all other respects, Supertalker II is a useful addition to the IBM PC.

Mountain Computer, Inc., \$565

SURGE PROTECTORS

Warning: Power-line pollution can be hazardous to your computer's health.

Surges, transients, spikes, noise, and other kinds of pesky pollutants are constantly lurking in the power lines all around you, and they'll get your computer if you don't watch out. Nothing pleases them more than making images on a screen jump up and down, garbling the data on a disk, or—in a worst-case scenario—deep-frying the microchips inside your Apple, Atari, Commodore, or IBM PC.

But don't panic: You can keep power pollution away from your computer. All you need is a good surge, spike, and transient protection system.

There are five main kinds of powerline pollution: power outages, brownouts, power surges, spikes, and noise. Let's look at each of these gremlins, one at a time.

Power outages, or blackouts, are relatively rare in urban areas of the United States but do occur now and then. You usually don't get any warning that a blackout is coming, and if one strikes while you're working at your computer, it will simply shut down your entire system, wiping out anything and everything that may be stored in RAM.

The best defense against a blackout is to arm yourself with an uninterruptible power system such as the Grizzly, manufactured by EPD (Electronic Protection Devices) of Waltham, Massachusetts. Inside the Grizzly there is an ultrafast warning circuit, plus a powerful rechargeable battery. At the moment a blackout hits, the Grizzly will sound an alarm and go online, and its builtin battery will become your computer's temporary power and light company. Even with the power off, the Grizzly will keep your computer supplied with full power for at least 20 minutes—certainly long enough to store everything in your computer's memory onto a disk or a tape for safekeeping until the lights go on again.

The EPD Grizzly is available in 200-watt, 500-watt, and 1,000-watt models that range in suggested retail price from \$895 to \$5,200.

The Data Sentry from RKS Industries of Scotts Valley, California, can also provide you with a continuous online power supply. It comes in two sizes: The DS-200, a 200-watt model that retails for a suggested \$695, and the DS-400, a 400-watt unit with a suggested retail price of \$995.

A *brownout* is a relatively large drop in line voltage that lasts for a relatively long time. When line voltage drops to more than 10 percent or so below its normal level, and stays that way for a few minutes or a few hours, a brownout is said to occur.

When a brownout hits, an uninterrupted power

system such as the Grizzly or Data Sentry can keep you from losing data. But if you live in an area plagued by frequent and severe variations in line voltage, it might be better to own a device equipped with a voltage regulator: for example, the Kleen Line regulator, filter, and suppressor from Electronic Specialists, Inc. (ESP) of Natick, Massachusetts. The Kleen Line conditioner is available in eight different models, with power ratings that range from 500 watts to 2 kilowatts and retail prices that range from \$364 to \$1,040. It can keep the voltage to your computer constant during brownouts, and also provides excellent protection against power surges, spikes, and noise—the varieties of power pollution which we shall take a look at now.

Power surges, also sometimes referred to a long-duration transients, are those voltage variations that you often notice when appliances such as air conditioners and refrigerators go on. As you've probably noticed, power surges can cause radios and television sets to do strange things; and they can also have undesirable effects on computers. They can slow down disk drives, cause video images on a monitor to jump and roll, and generally mess up programs and data. The Kleen Line conditioner, mentioned above, can help safeguard your computer from the effects of these long-duration transients. Less advanced protection devices can't help you out much if you're bothered by power surges.

Spikes, also called glitches, short surges, and short-duration transients, are the most troublesome forms of power pollution—the type most likely to damage your computer. Fortunately, they're also the easiest kind to filter out before they can do their nasty work.

Power spikes come from many sources, such as electrical storms, sudden changes in power loads, and the turning of appliances off and on. The most severe type of spike is one caused by lightning hitting a power line. There is almost no defense against that kind of an electrical disaster, but there are many products on the market that can safeguard a computer against less devastating types of short-term transients. These are the devices that are genetically known as surge protectors.

EPD, one of the best-known manufacturers of surge protectors, has a wide range of products in its catalog. The company is probably best known for a line of devices that derive their names from their colors. There's the Lemon AC surge protector, a yellow box that plugs directly into a wall outlet and provides six more wall outlets, all protected from spikes; the Lime, a green surge protector that looks much like the Lemon but has a power cord;

and the Peach and the Orange, which provide protection against high-frequency noise (to be discussed in just a moment) as well as against AC power surges.

The EPD Lemon has a suggested retail price of \$60—not cheap, but a real bargain when you consider the value of the equipment it can protect. The other products in the EPD line are more expensive; the most advanced device, the Orange, has a suggested retail price tag of \$139.95.

There are two main types of electronic noise—also known as “hash”—that can affect the operation of a computer: radio frequency interference, or RFI, and electromagnetic interference, or EMI.

RFI can be caused by CB radios, police and taxi radios, radio and television stations, and other kinds of broadcasting services. Other causes of RFI include arc welding, motors, and even noisy electric switches. Generally speaking the busier the electronic environment is around your home, the greater will be your problems with RFI.

EMI can be caused by lightning (even far-away lightning); solenoid-operated equipment such as vending machines and time clocks; and many other kinds of electronic and atmospheric interference that can sneak into your home's power lines.

Electronic noise is not nearly as dangerous to your computer as short-term transients are, but the frequencies of electronic noise can range up to 50 megahertz or more, and can therefore affect the operation of microprocessors—which usually operate at 1 to 8 MHz—as well as disk operating systems, which commonly use frequencies in the range of 50 to 500 kilohertz or so. What that boils down to is that electronic noise could cause malfunctions in the way your computer processes data, particularly if there's a lot of broadcasting and other kinds of electronic noises in your area.

EPD, RKS, and ESP offer wide selections of surge protectors that can also filter out RFI and EMI. Other manufacturers of surge and noise eliminators include Computer Power Solutions, Inc., of Pinellas Park, Florida; Networx, a company in Brooklyn, New York and Discwasher of Columbia, Missouri, a well-known manufacturer of audio, video, and computer accessories.

Networx is best known as the manufacturer of the Wire Tree, a four-outlet box that can be mounted either on a wall or upside-down under a table or a desk, and can therefore serve as an out-of-the-way extension cable as well as a line filter and surge suppressor. The Networx Wire Tree has a suggested retail price of \$70.

Electra-Guard makes three computer-protection devices: The \$50 Electra-Guard system 2, which

can protect six devices from line surges; the \$80 System 4, which can protect three devices from both surges and electronic noise; and the \$60 System 12, a "power bar" which has an on/off switch and a six-foot extension cord, and can protect six devices from power surges.

Discwasher now offers a new surge and noise eliminator called the Spikemaster. It is a very handsome unit with four outlets and an on/off switch, and is designed to protect computer hardware, computer software, and audio and video equipment from RFI, EMI, and short-duration power surges.

SYNTEC LIGHT PEN

When the Atari Light Pen failed to make the grade and was pulled from the market, it was left to third-party manufacturers to fill the gap. Syntec Corporation jumped into this breach with about the most professional light pen you can find for any machine. It is, in fact, an adaptation of the model used in professional mini and mainframe operations.

The Syntec Light Pen is made from heavy, extruded aluminum with a coiled telephone handset wire leading to an Amphenol connector. It includes a sensitivity trimmer adjustment as part of its standard equipment. The graphics capabilities available with a simple software driver are truly amazing, from a single line drawing to a full-blown portrait in minutes. It is all possible with this wonderful device. Of course, to create truly fine art you require fine software. This does not come with the Syntec Light Pen. The Atari owner is going to have to shop for it or write his own program.

If you wish to endow your Atari with professional light pen capability, the Syntec Light Pen is literally without rival on the market. It is solidly constructed and backed by a full one-year warranty. It is well documented, providing much more valuable information than the average Atari user is accustomed to. In fact, everything about the Syntec Light Pen is top of the line, including its top of the line price tag.

Syntec Corporation, \$150

SYSTEM SAVER

The System Saver is a well-made, color-coordinated cooling fan and surge suppressor that slides onto the side of your Apple II. If you are using your Apple with just one disk drive then you probably do not need the cooling feature of this unit, but once you start filling up your slots with expensive peripheral cards this is a wise investment.

In addition to the fan, System Saver replaces the on-off switch in the back of your Apple with a rocker switch in the front. This switch lights up when you turn on your computer and controls two outlets on the back of the System Saver so that your monitor and printer can be turned on and off with the computer—a very convenient feature.

Besides cooling your Apple, the System Saver protects your computer from power line noise and transient surges. This feature could save you from crashing a program with valuable data or even from crashing your entire system. The System Saver is useful accessory for most Apple owners that can protect their software and hardware investments.

Kensington Microware Ltd., \$89.95

SYSTEMCARD PACKAGE

Microsoft is not breaking any new ground with its multifunction Systemcard Package; however, this is a mature product designed with quality in mind. The Systemcard is a standard-size circuit board designed for the IBM PC. It loads four different functions onto one card and thereby saves expansion slots for other uses. The board comes with 64K of RAM (expandable to 256K), a Centronics-compatible parallel interface, an asynchronous serial interface, and a clock/calendar with battery back-up.

The Systemcard software includes terminal emulator, printer spooler and clock/calendar utilities. It also includes MEMTEST, a memory diagnostic program, and RAMDrive, Microsoft's disk emulation program. RAMDrive permits the user to allocate the card's memory as IBM system memory or as an electronic disk. It allows the user to assign a drive letter to any section of the memory just as if it were a disk drive. Programs can then use this memory as a virtual disk drive whose access time is much shorter than that of any physical disk drive.

Microsoft sets the standard for the rest of the industry with its documentation of this package. Anyone can install the Systemcard with the help of the fine instructions provided by Microsoft. The Systemcard is completely IBM-compatible and requires no translation software. Its documentation includes operating instructions and a troubleshooting guide.

Microsoft Corporation, 64K RAM \$475; 256K RAM \$995

TECH-SKETCH 10S LIGHT PEN

The Tech-Sketch 10S Light Pen aims to be an affordable and useful light pen for the home com-

puter market. It is currently sold in versions for the Commodore 64, Apple and Atari computers.

Like most light pens, it is slightly larger than a standard ballpoint and has a trigger about one inch from the tip, for signalling back to the computer. The Atari and Commodore versions of this pen plug directly into the computers's joystick port. The Apple version requires an additional plug-in card.

This is a mass-market pen, and users shouldn't expect the resolution of professional (read more expensive) models. The pen we tested with the Commodore 64 performed exactly as advertised, but the program supplied with the pen was balky. This simple program, *Paint-N-Sketch I*, allows free-hand drawing (lines were ragged, indicating a lack of resolution) as well as shape-making (lines and circles) in four colors. The pen had difficulty sensing different colors in dark areas of the screen and selecting from the function menu.

The company sells other software for the pen, including a level II version of *Paint-N-Sketch* and some educational games. Tech-Sketch also makes a higher-resolution pen, Model LP-15, but it was not available at the time of this review.

In all, the Tech-Sketch light pen seems to be too limited for serious applications, and the software included with the pen may be disappointing to many users.

Tech-Sketch: Apple \$139.95, Atari \$39.95, Commodore \$39.95; Model LP-15: Apple \$219.95, Atari \$199.95, Commodore \$199.95

TECMAR 1ST MATE

The Tecmar 1st Mate card is a multifunction card for the IBM PC and XT. It provides a by-now familiar cluster of functions: 0 to 256K of RAM, a serial port configurable as either COM1 or COM2 (or disabled), a parallel port configurable as either LPT1 or LPT2 (or disabled), a clock/calendar with battery backup and software to manage the board and use memory for print spooling and a "RAM disk." The 1st Mate takes up one slot in your PC. The parallel port connector is on a cable that fits in the hole of another slot and hangs out the back of your PC. It can be unplugged and removed if you don't need the port.

The memory portion of the board is parity checked and fully socketed, allowing you to add more chips over time if you buy less than 256K at first. DIP switches on the board let you locate the expansion memory anywhere in the PC's physical address space.

Before it will come on line, the Tecmar serial port

requires that the "Data Set Ready" (DSR) line be sent by the remote device. This is the correct way for an RS-232 port to function; most equipment will turn DSR on. If a device does not set DSR when it is ready, you can add a jumper to correct the problem.

Tecmar includes software that sets the time and date on the 1st Mate card. When you boot PC-DOS, another program must be run (from an AUTOEXEC file) to set DOS'S clock from the board's. Another program, called Speed Disk, lets you use up to 512K of memory for a fast disk drive. A print spooler lets you use up to 64K of memory to hold output for your printer until it is ready for it. Utilities for copying files and displaying disk directories are included. These utilities have many more display options than their DOS counterparts. All of this software works with DOS 1.10 or 2.0.

The documentation provided with the board is good, but some technical knowledge is needed to install and jumper your board correctly. If you're not sure that you have enough technical knowledge, you should probably have your dealer install this board.

The board works very reliably; however, the format in the DOS DISKCOPY command doesn't work if the print spooler is installed, and the calendar date changes erratically once in a great while, though this may be due to a run amok program that accidentally changed the date on the clock/calendar chip.

Requirements: IBM PC and PC/XT

Tecmar Inc., 0K RAM \$319; 64K RAM \$389; 128K RAM \$469; 192K RAM \$539; 256K RAM \$589

THE 32K RAM UNIT

It is nice to see companies directing their attention to the low-cost end of the computer market. A memory expansion card from Mosaic Electronics called the 32K RAM Unit provides an economical way to expand the RAM of an Atari 800 to its full 48K.

The RAM Unit uses high-quality 4116 dynamic RAM integrated circuits (each stores 16K) to provide 32K. The board is well-designed. Gold-plated edge connectors add reliability and adequate capacitor bypassing to ensure low-noise performance. The printed circuit board is not mounted in plastic housing as the Atari modules are, and this may improve heat dissipation. The board is designed to take advantage of the Atari bus structure by incorporating proprietary board-enable circuitry. It may be used with 8K or 16K memory boards in either of the first two memory spaces.

One further advantage of the Mosaic design is that, with the addition of an inexpensive expansion card, the device may be used without additional RAM boards.

Setting up the board is uncomplicated—just unpack the card and plug it in. The package includes full documentation for installation and use. Once the board is in place, there is no discernable difference in screen clarity. This indicates that the board does not strain the power supply or the system bus.

The 32K Byte RAM Unit is a good buy. It costs less and generates less heat than two 16K memory boards. By replacing at least two cards, the RAM Unit leaves a slot available for expanding the 800 system.

Mosaic Electronics, \$49.95

3 COM ETHER SERIES PC NETWORK

Networking computers is a serious and costly business. Designed primarily for an office environment, networks do not become cost-effective until enough computers are added to the system to bring down the per-unit cost. For the larger users, the best system to date may be 3 COM's Ether Series PC Network for the IBM Personal Computer.

The heart of the system is the EtherLink card. This single card contains everything required to interface the PC network to the bus of one IBM PC. The card comes with software and a manual. The same card along with the extra-cost server software transforms an XT or hard disk equipped PC into a network server.

The EtherShare software provides the personal-ity for the system. By itself, the basic EtherShare setup is limited to allowing users to share the server's hard disk. Multiple users can be on the network simultaneously. EtherPrint is a software option that supports one or two printers in a true print-spooling mode. A log-in procedure selects the printer to be used and links to the PC device name you request. After the link is established, all printer output, including program output and screen prints, are sent at network speed to a spool file on the server disk and queued for printing on a first-in, first-printed basis.

Selecting a network is very similar to selecting a business computer. Both are tools, and if the wrong tool is selected there will be a price to pay. 3 COM is offering a high-quality, high-performance product that could be called the Rolls Royce of network systems. It is not for everyone. Connecting a few PCs in a low-traffic network would certainly not be cost effective. On the other hand, if you need to connect 50 or more PCs in a net with sev-

eral file servers, EtherShare may be the best choice.

3 COM, \$860

THUNDERCLOCK PLUS

The Thunderclock is an accessory for the Apple computer that allows it to automatically read the time and date.

Installation of the battery backedup Thunderclock Plus is simple. Coupled with the appropriate software, it allows you to know when you received, entered, or saved a certain bit of data, information that is sometimes as important as the data itself.

Apple Computer believes that time/date stamping of disk files is so important that ProDos, the new Apple disk operating system, performs this task automatically. The Thunderclock Plus is the card that Apple specifies for use with ProDos, and this is one of the strongest recommendations available.

Most software manufacturers will soon incorporate the Thunderclock protocols into their programs, if they don't already, because of Apple's endorsement. If you are using DOS 3.3., Pascal, or CP/M and want to time/date stamp your files, then Thunderware will, for an additional fee, sell you a utility that will upgrade your disks so that they can make use of Thunderclock.

For those of you who do your own programming, the Thunderclock Plus is packed full of firmware (programs in ROM) that makes getting input from the clock a breeze for even the beginning BASIC programmer. For Assembly language devotees, the manual and utility disk contain plenty of information and examples of how to use the card.

The Mountain clock card was the old clock/calendar standard that everybody emulated. The Thunderclock claims to be Mountain clock card compatible but it really isn't; however, it does have the ability to output the time in the Mountain clock card format.

If all the other features of the Thunderclock aren't enough, then how about having your computer water your lawn when you are at work, turn on your coffee pot before you wake, or send messages over the telephone while the rates are cheapest? All of this is possible with the Thunderclock because of its ability to generate interrupts and to emulate the BSR/X-10 ultrasonic controller. This requires an inexpensive adapter (purchased separately) that lets you control remote power modules around your home through the power lines.

Thunderware, Thunderclock Plus \$150; DOS Dater \$29; Pascal \$29; BSR Interface \$49

TI MEMORY UPGRADE KITS

Texas Instruments offers two memory expansion kits for the TI Professional Computer family. They are designed for users who want to expand memory beyond the 256K of RAM that are available on the Professional's mother board. These kits increase the main memory up to 786K, in 256K increments.

Each Memory Kit consists of a full-size expansion board that occupies one of the five expansion slots in the TI Professional Computer as well as a smaller piggyback board that attaches to the first. The boards use TI's own production-proven TMS 4164 64K dynamic RAM chips. Also included with the base board's kit is an installation manual and a diagnostic diskette. No software is provided for printer spooling or disk emulation.

The boards are very well-constructed and, of course, totally compatible with the TI Professional. Installation is simply a matter of opening the computer and slipping the new board into place.

The Memory Upgrade is very expensive, and print spooling and disk emulation would make it much more useful. Outside vendors include such programs as part of their kits, and, adding insult to injury, they do it at about half the price of the Memory Upgrade.

Texas Instruments, \$795; piggyback board \$695

TIMEMASTER II

A full-featured clock system for the Apple computer, *Timemaster II* supplies year, month, date, day-of-week, and time in both 12- and 24-hour formats. It is precise down to one millisecond. It fully emulates Mountain Hardware's *Appleclock* and most other clocks.

Timemaster II is fully compatible with Apple's new *Pro-DOS* and can automatically time/date stamp *Pro-DOS* files. A *DOS Dater* program included allows you to modify DOS 3.3 to time/date stamp those files automatically. An on-board 2K ROM lets you read the clock with a single BASIC line.

Well-constructed of high-quality components and fitted with gold contacts, the board contains a rechargeable NiCad battery that will keep the clock running even when the computer is off. The battery is said to last over ten years and will keep the clock running for five to seven months without being recharged. The battery is continually being charged when your Apple is on, but cannot be overcharged. Included is a ± 30 -second adjust switch to synchronize the clock along with a small trimmer to adjust the crystal frequency.

Other features include software-controlled interrupts for foreground/background programming, interval timing up to 48 days, compatibility with CP/M and Pascal, and low-power compact design.

Included with *Timemaster* is a disk containing over 25 programs ranging from simple clock demonstrations to routines you can use in your own programs. The disk is unprotected and may be copied. It comes with a three-year warranty. It's an excellent value!

Compatibility: Apple II, II+, IIe, and Franklin Applied Engineering, \$129

TI RAM CARD

Until recently, expansion cards for Texas Instruments' Professional Computer were available only from TI. Quadram was one of the first to change that with their high-quality, low-cost TI RAM card.

The TI Ram Card increases the random access memory of the Professional Computer from 64K to 256K. It is a standard 3-inch card designed to fit in the expansion slot located at the front left edge of the computer's motherboard. The RAM Card contains three 64K banks with ten chips per bank. Eight chips in each row are for data memory, one is for parity checking, and the last chip is for system interface circuitry.

The 192K of extra memory that this card supplies can be used to run long complicated programs or, when used with appropriate software, as a solid-state RAM drive. At the time of this review, Quadram had not completed its software program for disk emulation.

The RAM Card's documentation includes clearly illustrated instructions for installation, and the board slips right into place. Quadram claims that each card is "burned in" and tested for quality before shipment, and this certainly appeared to be true. The TI Professional Computer ran smoothly with the RAM Card installed during testing for this review. Obviously, the RAM Card meets all of the access-time specifications of the Professional.

Quadram Corporation, \$275 to \$425

TIME SPECTRUM SB 384

The Time Spectrum SB 384 is a single board product that allows IBM PC users to add up to 384K RAM to an IBM PC already configured with 256K memory.

As standard features the Time Spectrum offers socketed RAM, a calendar/clock with rechargeable battery backup, an asynchronous communications port and a Centronics or Dataproducts compatible

parallel printer port. An optional game port for joysticks is also available. A nice touch is switch-selectable addressing on any 64K boundary and switch-selectable memory size. If you already have, for example, a system with 256K of memory and you only need an additional 128K, you can set the switch for 128K without altering the memory space assignments for devices and controllers that use higher memory.

Time Spectrum SB 384 comes with the Personal Products Systems Instadrive solid state disk simulator and the Waitless Printing print spooler software. The Instadrive enhances processing performance by serving as a fast access RAM disk simulator that provides up to 320K of user-assignable storage. It can be manually or automatically activated. Waitless printing provides automatic spooling for both serial and parallel printers. Both software packages run under PC-DOS 1.0, 1.1 and 2.0 without modification.

The Time Spectrum SB 384 is a good package, well documented and offered at a fair price.

Personal Products Systems Technology, \$395

TOMORROW HOUSE

Tomorrow House is a turnkey home monitoring and control system from Compu-Home Systems. It uses the Apple II computer and consists of a plug-in circuit board, a junction box, hardware for hook-ups and all the software programs you need for setting it up in your house. It also includes an installation manual and a user's manual.

Tomorrow House lets you schedule heating and cooling systems up to nine weeks in advance with as many as 48 changes per day. You can also automate your lights, appliances and even your hot tub for maximum energy conservation. Complex schedules for different circumstances can be stored and recalled for execution whenever necessary. Home security is handled with verbal warnings as well as an easy-to-read graphics display of your home's floorplan and status. Convenience features include a voice wake-up call and a record-keeping system that tracks each time Tomorrow House is booted or an alarm is detected.

This is a sophisticated system that will bring your home into the future. It is not inexpensive or uncomplicated. While it is offered in kit form, it is strongly suggested that you have a qualified dealer install this turn-key system. A Tomorrow House system for a small apartment will cost about \$1,000, depending upon the options chosen. If tight security in your home is a much desired option or an absolute necessity, the Tomorrow House

offers you a lot of advantages over a standard burglar alarm.

Compu-Home Systems, Inc., basic system \$895

TOPAZ POWERMAKER

It's bigger and heavier than some personal computers, costs as much as many good printers, and draws power from the wall 24 hours per day, seven days a week. You may never use it. If you do use it, it will stop working in as little as nine minutes, even if you are not finished with it. Why on earth would anybody buy one? Because one day you'll wish you had an uninterruptible power supply that assures a constant supply of power for your computer even when the lights go out.

If you've been looking for the right uninterruptible power supply for some time, the Topaz Powermaker may hold the answer for you. There are four models available, with differences in price based on the amount of standby current provided, and the length of time the Powermaker will operate on its own internal batteries. Several of the models supply a signal to the computer, causing an orderly, unattended shutdown if the computer has been programmed to do this. Some computer owners consider the purchase of uninterruptible power supplies after a disaster or near miss. Smart computer users profit from the experiences of others.

Topaz Electronics Inc., \$750 to \$995

TRACK HOUSE II TENDER KEYPAD

The Apple IIe is a fine computer whose basic design has been around since 1977. This system has remained a best-seller for all these years because of its "open design" and the tremendous third party support it has received from both software and hardware designers.

One area where the Apple IIe comes up a bit deficient when compared to the new crop of systems available now is in the keyboard. The IIe's true upper-lower case keyboard is a genuine improvement over the original "teletype" one, but Apple has still not seen fit to provide us with a keyboard containing a numeric pad. Considering the number of these systems used for accounting and spreadsheet applications, this omission becomes even more glaring.

The Track House IIe Tender Keypad attempts to make up for this deficiency in the Apple's keyboard. It is a well-designed product, but it suffers somewhat in the execution of the design. It is a small "Apple beige" box about seven inches

square that slopes to a height of about an inch and a quarter in back.

The keys on the pad are divided into two groups. On the left is a standard 10 keypad augmented with "DEL", "*", "/", "+", "(", ")", and an additional "ENTER" key. The group of keys on the right consists of the four cursor keys, a "SPACE" key, and a group of four user programmable keys. These keys, programmed by a set of small matrix switches located under a trapdoor on the pad, can be set to function as any key on the keyboard except "RESET" and the "OPEN APPLE" and "CLOSED APPLE" keys. *VisiCalc* became much more enjoyable with the Tender keypad, as most of the keys needed to operate it are located on the pad. For this use you would probably define the programmable keys to represent the functions you use most often, such as an "R" for Replicate. The keypad is also available with *Coupler-Calc*, a program that turns the Apple into a 10-key desk calculator.

Installation is a 10-minute process which involves unplugging the IIe's keyboard from the motherboard, plugging a ribbon cable into this connector (which is attached to a DB-25 cutout in the Apple's rear), plugging the keyboard into a spare connector on the ribbon cable, and plugging the keypad into the DB-25 connector.

Track House, \$199; Coupler-Calc \$29.95

TURBO-186

Orchard Technology's Turbo-186 is an Intel 8086 coprocessor for the IBM PC. Depending on what software is being run, this board can increase the speed of the PC 3- to 10-fold.

In addition to the 8 MHz coprocessor, the Turbo-186 board has a 16 bit data memory bus and 128K of memory. Sockets are provided for on-board memory expansion to up to 256K. Orchard Technology has also designed a piggyback board for the Turbo 186. With the addition of this board, total system memory can be increased to 640K.

The package's software is called MCI Turbo-186, and it allows MS-DOS programs to run transparently on the 80186 coprocessor. It also allows the IBM PC's 8088 processor to run concurrently, handling all of the system's input and output. Programs are also provided for disk emulation and printer spooling.

Installation is a smooth, problem-free process, thanks to Turbo-186's fine manual. It is detailed, well-organized and clearly written. Once the board is up and running, it is fast. Typical programs run at an average of five times their speed on a standard IBM PC.

Orchard Technology, \$995

UNIVATION RAM BOARDS

Univation has two new memory expansion boards for Rainbow 100 users. Up to 512K total RAM is now available to Rainbow users.

Univation sets new standards by offering "piggy-backing" as well as socketing. Univation's two boards stack together to provide as much as 448K of expansion memory. The first board comes standard with 64K RAM. It plugs into the Rainbow memory option position. This board is also available with 192K. The second board is the "piggy-back" module. It attaches directly to the top of the first board. This module is available with either 128K or 256K RAM.

Included with the boards is RAM disk software that lets the user load programs directly into the RAM. Memory space can be allocated so that user-defined capacity is dedicated to running software, while the remainder of memory can be used as working space.

Installation takes only moments with the help of Univation's comprehensive instruction manual. Compared with an IBM PC memory upgrade, the Rainbow upgrade is a snap—no tools, no DIP switches, no need to remove other boards.

The tests run for this review ran without incident and incurred no problems. The 448K board did not tax the Rainbow power supply, even with a Winchester drive running off the same supply. Heat generation was not a problem. Univation backs its boards with a one-year warranty.

Univation, 64K RAM (expandable to 192K RAM), \$295; 192K RAM, \$550; 448K RAM (expandable to 512K RAM), \$1,095; 192K RAM "Piggyback" board, \$300; 256K RAM "Piggyback" board, \$575

VERSARAM PLUS II

Just how many modules can be crammed onto a multifunction board before it is full? Memory Technologies has gone one up on most other multifunction boards by including a color graphics adapter module on its VersaRAM Plus II board.

The basic board is designed for the IBM PC or XT and comes with 64K of RAM and a clock/calendar. Its documentation includes installation and instruction manuals. The board's software includes printer spooler and clock/calendar utilities as well as disk emulation and diagnostic programs.

All of the other functions available for the VersaRAM are provided as additional cost modules. These include: up to 192K of RAM on the main board, 256K on a piggyback board, a printer

spooler module, a color graphics interface module, an asynchronous interface and a parallel interface.

Having all of these modules on a single board does save a lot of PC expansion slots, but at what cost? The VersaRAM board is expensive and has a few limitations. The printer spooler module's buffer is limited to 128K. While this is not necessarily an earthshaking problem, Memory Technologies could have made the buffer limit user-definable. The use of the color graphics interface is severely limited. This module is fully IBM-compatible; however, it cannot be used simultaneously with the RAM module. Greater versatility is offered by many other graphics interfaces.

The VersaRAM PLUS II is a well-engineered and well-designed product that offers a lot of options in one IBM expansion slot. However, some consideration should be given to its price and its limitations before purchase.

Memory Technologies, Inc., \$1,680 with all options

VERTICOM

Verticom terminals have the very useful characteristic of allowing the mixing, through software, of text and color graphics. Graphics created with Verticom's color graphics terminals can be displayed on any other system using a new but widely used standard code called NAPLPS, which stands for the North American Presentation-Level Protocol Syntax.

Verticom offers two NAPLPS-compatible terminals: the PLP 100 and the PLP 200. The two models are very similar, but the PLP 200 has more standard features, including an auxiliary serial port for a mouse and interactive firmware that supports page creation. These features are optional on PLP 100.

NAPLPS was developed for the transmission of Videotex into the home, and has been endorsed by more than 20 hardware manufacturers and government agencies as the graphics standard for Videotex communications. With NAPLPS, business graphics can be created and intermixed simply and easily, and can be interchanged freely among users of the NAPLPS system. The coding is efficient, so complex pictures and designs can be created using relatively little data. Verticom and other proponents of NAPLPS feel that the system is ideal for business users who need cost-effective transmission of graphics and text via telecommunications across the office or around the world.

One important feature of Verticom's terminals is the ability to create your own character sets; you can use a familiar set that you happen to like, or

you can invent a whole new one. Once you've defined a character set, you can name it and store it, and you can then call it up whenever you like. You can also redefine the terminal's keyboard to allow your new character set to be used more easily. You can also use NAPLPS to add color graphics to your current software, according to Verticom.

The NAPLPS system also includes an easy-to-use animation technique. The system allows graphics characters to be flashed on and off at varying intervals, and you can flash from one incarnation of a graphics character to another using simple commands. Once you've mastered this flashing technique, you can easily create animation sequences and then name them. And once you've named a sequence, you can recreate it at any time by merely typing its name.

Both terminals are three-piece systems, made up of a keyboard, a monitor, and a control unit. And both are compatible with the standard ASCII character code, as well as with the NAPLPS system. Each terminal is equipped with dual microprocessors, 320K of display memory, and 2K of non-volatile CMOS RAM with battery back-up. With the addition of the appropriate hardware and accessories, both terminals can be expanded into stand-alone computers with outstanding graphics capabilities.

Both Verticom terminals are compatible with Digital Equipment Corp.'s VT-100 and the Tektronix 4010. And each terminal includes two pages of graphics display memory, so you can work on one page while saving another. Ease-of-use features include a tilt-and-swivel monitor, a keyboard palm rest, nonglare sculptured keycaps, and integrated document holder. The terminal software is menu-driven, providing prompts and tutorials to help the operator.

The monitor that comes with the terminals has a 13-inch antiglare color screen with a resolution of 640 by 480 pixels. Up to 16 colors can be displayed on the screen simultaneously, from a palette of 4,096 colors and hues. There are eight programmable combinations of foreground and background colors displayable at one time. In its text mode, the monitor can display either 80 columns or in 132-column mode.

The Verticom keyboard is a low-profile model with 105 keys. The PLP 100 and PLP 200 have 23 more keys than the DEC's VT-100, including 10 additional function keys. Both have an optional light pen attachment, and a 32-bit parallel port access to the display processor.

Verticom, POP-100 \$5,650; POP-200 \$6,450

VIDEX ULTRATERM

The Videx Ultraterm is not just another 80-column card for the Apple II, or II+; it is capable of displaying 80, 96, 128, 132, or 160 columns of characters. It also enhances the video display for the entire line of 6502-based Apple computers. If you have one of the earlier Apple computers and have been thinking about moving up to an 80-column display, then this is the card to get.

The most interesting aspect of the Ultraterm is not its amazing 160 by 24 or 80 by 48 character display, but rather its compatibility with the Apple IIe and Apple III (only in emulation mode at this time). Why would anyone want to use an external 80/160 column card on two machines that already have an 80-column capability? Simple—the display quality of the Ultraterm is a vast improvement over the standard display of the two later models of Apples. This is due to the higher density character matrix (7×9 or 9×12) produced by its state of the art video circuitry. In other words, you get fully formed characters on the screen.

To appreciate the magic of this board, you must use it with a high resolution monitor that has long persistence phosphors that result in longer-glowing dots on the screen. Longer persistence allows the Ultraterm to write the characters on the screen in two passes, which is how many new dot-matrix printers produce near letter quality. The Ultraterm, like a dot-matrix printer, fills in the gaps between dots on the second pass to produce characters that are fully formed. This process is called interlacing. Of course, to get this amazing display you will need to use a monitor like the Amdek 300A or the Apple Monitor III (but Apple's intentional overscan restricts you to 132 columns). Do not expect to use this card with the Apple Monitor II or with a television.

Hooking up the Ultraterm is a snap, thanks to the excellent instruction manual which features step-by-step instructions for the different Apple models as well as a large section on problems that you might encounter. For the Apple IIe users with extended memory, Videx has a pre-boot for Applewriter II and IIe or VisiCalc that allows you to use the extra memory for text or models when you are using the Ultraterm.

If you don't already have a spreadsheet program, you should consider *Ultraplan*. This program is a special version of *Magicalc* and is typical of the new spreadsheets; however, it allows complete access to many capabilities of the Ultraterm, as well as those of the Apple, Saturn and Legend memory boards.

Unfortunately, the Applewriter II pre-boot only al-

lows 80 by 24, 80 by 32 and 80 by 48 display modes, and it slows down certain operations such as updating the screen and getting a catalog of the disk. This wastes many of Ultraterm's impressive display capabilities; however, all of these capabilities are supported by Word Juggler IIe, a very sophisticated word processor.

For all of you who have software compatible with the Videx Videoterm, the Ultraterm automatically boots up in a Videoterm emulation mode that allows compatibility.

If you are dissatisfied with the display capabilities of your Apple or want to see your entire spreadsheet model on screen, the UltraTerm provides a path to substantial improvement that doesn't require scrapping your present computer system.

Videx, Ultraterm \$379; VisiCalc pre-boot \$69; Applewriter pre-boot \$29; Ultraplan spreadsheet \$169

VIEWMASTER 80

Eighty-column boards for the Apple II are legion these days. Some cost over \$300. Each has unique features and many work only with certain programs. Viewmaster 80 comes close to being the ideal low-cost board that works with everything. Fully Videx-compatible, it offers many extra features and works with CP/M, Pascal and nearly every software package that supports 80-column boards. Although Viewmaster is fully compatible with both VisiCalc and Applewriter II, you must still use the Videx pre-boot disks.

The first thing you notice is the quality of Viewmaster 80's construction. Fully socketed with mil-spec components, the boards are glass epoxy with gold contacts. Next, you notice the quality of the display. Using a 7-by-9 dot matrix, the characters are sharp and easy-to-read and have true descenders. Viewmaster 80 includes an on-board 40/80 column soft video switch with provisions to connect a 40-column absolute override switch and a light pen.

Upper- and lowercase are handled through either the CTRL-A function (both shift and shift lock) or the use of a one-wire shift key modification. The Viewmaster automatically senses if the shift key mod is installed and, if it is, CTRL-A becomes the shift lock only. The board supports the HOME command as well as all the standard ESC screen editing commands. It also responds to various control characters for cursor and video control from within programs.

Viewmaster 80 also features inverse video, a user-modifiable EPROM character set, programm-

able cursor shape, special character entry, low power consumption and a three-year warranty.

Applied Engineering, \$169

VOICE RECOGNITION BOARD

Star Wars has arrived for the IBM PC. C3PO carried on conversations with other computers, humans and human-like creatures in a voice not too different from what we hear every day. The state of the art is not so refined yet, but the Voice Recognition Board from Tecmar is a step in the right direction.

A small speaker is set onto this standard long board. The board appears to be well designed. A single jack on the back of the board allows it to send output to either an external speaker or an amplifier. While the sound from the internal speaker is adequate, the sound quality is improved and it is easier to adjust the level when using an external amplifier. The Voice Recognition Board is a "smart board" that uses a Motorola 68B03 micro-computer chip and a 4K control program to allow you to specify one of the board's 17 functions.

Very little software is available for this board at present. The board's documentation seems to be aimed at very experienced programmers. These two factors may limit the market for this revolutionary board. Evaluating this board was made difficult by this lack of software. Even with these limitations, evaluation of this innovative device showed its great capabilities and promise.

Tecmar, Inc., \$995

WILDCARD 2

The problem with most good software is that it is copy-protected. To avoid having to send crashed program disks back to the manufacturer, you must resort to creating back-up disks with a bit copier. This bit copying approach often works, but it leaves you with a copy of the same protected disk.

The Wildcard 2 system allows you to back-up your software and remove the protection. The ability to convert your protected programs into unprotected DOS 3.3 files is a tremendous asset for back-up or archival storage. Also, if you have a storage device that uses a nonstandard DOS (such as a hard disk, an 8-inch disk or a double-sided drive), the Wildcard allows you to transfer your programs to it. Using the Wildcard, it is possible to combine a copy-protected pre-boot disk and a copy-protected word processor into a fast loading binary file on a single unprotected disk.

The Wildcard 2 works by interrupting your program while it is running. It allows you to make an

auto-booting disk, with a copy of all the information in the memory of your Apple II or IIe (Wildcard 2 allows copying of the extended memory of the 128K Apple IIe). Wildcard 2 must be in the machine in order to use these auto-booting disks. But, once you have a snapshot of memory with your program saved on disk, you boot the Wildcard 2 utility disk. This disk contains menu-driven programs which guide you through the steps necessary to make BRUNable files. These files are then BRUN from any DOS 3.3 disk. Even though Wildcard 2 creates DOS 3.3 files, it is possible to make copies of programs that use different operating systems, like ProDOS. A bonus of the Wildcard 2 is that it can dump the 40- or 80-column text screen to a printer, allowing you to make a printed copy of any text display on your computer.

The chief limitation of Wildcard 2 is that it works by copying everything in memory, so that programs that need constant access to the disk (like many adventure games) will not be easily copied by this system without the help of a bit copier. But, if you want to protect your investment or translate your protected software into a non-protected format, then the Wildcard is the card to get.

Central Point Software, \$139.95

THE WORKS

If you are a TRS-80 owner who has been longing to take advantage of the powerful features of *WordStar*, you can have the flexibility of CP/M for free as well, if you buy The Works. Omikron Systems has bundled The Works with software that is worth a great deal more than the hardware modifications alone.

Any computer novice can install The Works by following the simple instructions included in the package. Once it is installed, the user simply presses "T" for TRS-80 or "C" for CP/M operation as soon as the computer is turned on. The Works was designed to be used with either TRS-80 Model I or Model III computers, and, in separate versions, it will support 8-inch and 5¼-inch drives. Serious business users probably should look into getting the 8-inch drive version. The available disk space when using CP/M on single density disks is so small that business databases would be very limited.

The newcomer to CP/M is very likely to be overwhelmed by the Digital Research manuals supplied with the package. The manuals' authors seem to assume that the user is a computer expert who perhaps assisted with the writing of the source code for CP/M.

One possible problem with this system could be

caused by the TRS-80 64-column, 16-line screen format. While Omikron has compensated for this, the standard for CP/M 2.2 (the version supplied) is an 80-column, 25-line format. Although none of the programs supplied with The Works suffers problems with this format difference, some difficulties may be encountered with other programs.

The Works is an excellent value. The software, alone, included in the package is worth more than The Works' purchase price.

Omikron Systems, \$299

XTRAVIDEO I

The Atari 400 is all but gone from your dealer's shelves. In the last few months quite a few have been purchased for less than \$100. Many people bought them as second computers. Others bought them, installed a keyboard and a 48K byte memory card, and had the near equivalent of an Atari 800 computer. The Atari 400 is essentially the same machine under the hood as the Atari 800, except for the video monitor output that the 800 provides. Now there is a modification you can make to your Atari 400 computer which will give you a monitor output. The modification is called the Xtravideo I and requires no soldering or other special skills to install. This module replaces the CD 4050 integrated circuit and provides a composite video signal via a cable terminated in an RCA phono connector.

Installation is a straightforward affair. By following the simple instructions provided, the novice user will be up and running in just a few minutes. Best of all, the monitor output does not affect the normal RFTV output. The Xtravideo I works very well without putting any strain on the Atari 400 power supply. Screen images are clear and sharp and there is no visible difference from the output of an Atari 800. Hardsell takes a novel approach by providing a lifetime warranty. Not bad for a product that costs less than \$40. Which, by the way, is not very much, considering the added function you get.

Hardsell, \$39.95

Z RAM CARD

What would you say if you were offered a way to multiply the applications available for your Commodore system tenfold, have access to many high-level languages, such as Business BASIC, FORTRAN, and COBOL, plus have expanded user memory and a number of advanced hardware interfaces all at the same time? You would probably assume that this pushes things too far, especially on a mi-

crocomputer. However, these capabilities can be a reality by using a simple hardware add-on for the PET or CBM which allows use of CP/M.

The Z RAM Card from Madison Computer is a separate card containing two Z-80 microprocessors, a 6502 microprocessor and 64K of additional RAM. The card is designed to fit inside the top of the PET enclosure, directly under the monitor. Four mounting screws make installation a snap. It is configured to work with either a 40-column PET or an 80-column 8032 system. The advantage of the 8032 is that most CP/M programs were originally designed to support 80-column terminals.

To use the CP/M with Z RAM, just boot the supplied CP/M disk. After a brief wait (CP/M is a short program), the opening message will be displayed, along with the ready prompt.

The Z RAM Card functions without a hitch. Even the expected heat build-up did not occur. One side note: CP/M is not the most efficient with disk space. Using Commodore's 8050 disk with a total of 500K bytes on a diskette will yield a more effective operating environment.

Madison Computer, without CP/M, \$495; with CP/M, \$695

Z-80 PROCESSOR BOARD

The first thing a user thinks before moving up from a Z-80 computer to the IBM PC or XT is, "What do I do with all of my CP/M software?" A typical user is likely to have thousands of dollars tied up in software that will not run on the new computer. California Computer Systems has come to this user's rescue with its Z-80 Processor Board.

The Z-80 board enables IBM PC users to execute CP/M 2.2 and CP/M 3.0 programs. It is a smart board with its own Z-80B microprocessor running at 6 MHz. Actually a mini-multifunction board, it offers up to 192K bytes of dual-ported memory and an asynchronous communications interface. 64K of memory are available when using CP/M 2.2, 192K are available when using CP/M 3.0, and this memory may be used by the PC's 8088 microprocessor when the Z-80B is not in use.

California Computer Systems has put together a package they can be proud of—both the hardware and the documentation that arrives with it are of excellent quality. The Z-80 Processor Board supports more utilities than are claimed in its advertising, and it offers a truly useful service. For Z-80 users who require more processing power and speed, there is no longer any reason to delay moving up to an 8088-based IBM PC or XT and no longer any need to throw away CP/M software.

California Computer Systems, 2-80, \$250; AD 8088 processor card, \$345; copy system, \$995; QUAD COLOR, \$569; DISITHIZER 2E, \$649

Z-80 VIDEO PAK

The Z-80 Video Pak is a rather unusual add-on for the Commodore 64 in that it includes software programs (not utilities) along with an integrated cartridge. The package includes a word processor, a spreadsheet and a cartridge containing an 80-column screen adapter as well as Z-80 microprocessor.

The Z-80 microprocessor runs with the SB-80 operating system, which is also included in the package. SB-80 is compatible with CP/M and will allow thousands of programs written for CP/M to run on the Commodore. The 80-column adapter provides a high-quality monochrome display and contains software on ROM that handles the ASCII conversions and the communications operations that allow the Commodore 64 to act as an 80-column terminal for sharing services and in-house mainframes. In addition, the Video Pak provides full 80-column support for the Commodore BASIC that is built into the Commodore 64. The 40-column version of CP/M will also run on the Video Pak.

Video Pak's word processor is an 80-column version of *Word Manager* that includes many features. It comes with a self-adhesive feature strip that provides a quick reference list of all functions.

The spreadsheet, called *Plan Manager*, has an easy-to-use screen design. It can handle up to 63 columns and 254 rows. These rows may contain numbers, titles and formulas without restriction.

The Z-80 Video Pak is a good value. It adds useful features to an already good computer and throws in two very good software packages free of charge.

Data 20 Corporation, \$299.95

Z/PLUS

The Z/Plus package adds a Z-80B coprocessor to an IBM PC, IBM XT or IBM-compatible microcomputer. This allows the computer to run CP/M-80 (version 2.0) and programs written to be run under CP/M. Z/Plus actually runs the CP/M operating system; it doesn't just add header blocks to CP/M program files. The package includes a board with a Z-80B processor, either 64K or 192K of RAM and an RS-232C asynchronous serial interface. The package also includes a diskette that contains the CP/M operating system and most of the conventional CP/M utilities.

At the time of this review, Z/Plus does not include some standard CP/M utilities, notably *SYS-GEN.COM* and *MOVECPM.COM*. The *DISK-COPY.COM* program provided instead of these two utilities cannot be used on some IBM-compatible computers.

Z/Plus does not provide any facility for reading PC-DOS diskettes. This makes it difficult to move IBM programs or data into this system without having a second CP/M computer and some sort of communications software.

Documentation is sketchy. It consists mostly of reprinted Digital Research CP/M manuals and lacks detailed information about board installation, memory assignment, interprocessor communication and more.

Once it is operational, Z/Plus runs well, and the availability of CP/M-80 on an IBM PC will be particularly attractive to users who have owned CP/M machines but are now moving into PC-DOS or MS-DOS systems. With further software development and increased documentation, Z/Plus should become a practical add-on.

California Computer Systems, \$645 with 64K; \$825 with 192K

GLOSSARY

Access: To obtain data from or put data into memory; alternatively, to log on to an on-line database or bulletin board.

Acoustic coupler: An electronic device that converts computer data into audible tones that can be transmitted over ordinary telephone lines via the telephone's handset.

Add-on: Attached circuitry or components that upgrade or modify a computer's functions.

Address: A specific location in memory where information is stored; also, the identification code of an I/O port.

Algorithm: A sequence of mathematical or logical steps designed to solve a problem.

Alphanumeric: Alphabetic (A-Z) and numeric (0-9), as in the phrase "alphanumeric characters."

Analog computer: A computer that operates on the input of continuously fluctuating physical variables, such as temperature, flow or pressure, representing them as changes in voltage, electrical current, or some other physical variable rather than as binary numbers; mostly used in specific scientific applications. Compare with digital computer.

Application program: Software designed to solve specific problems; word processing and database management are examples.

Artificial intelligence: A field of computer science that deals with the programming of computers to mimic functions of the human mind. See robotics.

ASCII: Acronym for American Standard Code for Information Interchange (pronounced "ass-kee"), a standard method of encoding characters used in sending data between computers and peripherals.

Assembler: A computer program that translates assembly language programs into binary-coded machine language.

Assembly language: Low-level, symbolic programming language easier to use than machine language but harder than high-level languages like BASIC, FORTRAN, or Pascal.

Asynchronous transmission: A mode of transmitting data between computer devices one byte at a time. Compare with synchronous transmission.

Auto answer: A modem that automatically answers the telephone.

Auto dial: A modem that automatically dials and redials specified telephone numbers.

Auxiliary storage: Storage of data on media other than the computer's main memory, such as magnetic disks and tapes.

Backup: A duplicate of important data made on a separate storage medium in case the original is damaged or lost.

BASIC: Acronym for Beginner's All-purpose Symbolic Instruction Code, an easy-to-use high-level programming language.

Baud rate: The rate at which information is transferred between computer devices, roughly equivalent to bits per second (bps).

Benchmark: A program designed to test the performance of a computer system, compiler, or other equipment or software.

Bidirectional printing: A means of increasing printing speed by printing both right-to-left and left-to-right.

Binary: Notation system in which only two digits, 0 and 1, represent all numeric values.

BDOS: Basic Disk Operating System; the part of the CP/M operating system that governs disk functions.

BIOS: Basic Input/Output System; the part of the CP/M operating system that routes data between the keyboard, screen, printer, and other components. BIOS must be configured for each computer, usually by the manufacturer.

Bit: Basic unit of data in a computer. Bit is short for binary digit and can have a value of 0 or 1.

Block: A group of juxtaposed records in memory treated as a logical unit.

Boot: To start up a computer by loading initial instructions into RAM. A cold boot occurs when the computer is first turned on, while a warm boot loads a new program without a system reset.

Bps: Bits per second, indicating speed of data transfer. See baud rate.

Branch: A program instruction that will initiate transfer from one sequence to another; a branch is "conditional" if it checks for certain conditions before executing, "unconditional" if it does not.

Bubble Memory: A solid state mass storage device used in place of disks.

Buffer: A temporary storage device that compensates for transfer speed differences between com-

puter devices, such as computers and printers. Also, an area of memory set aside by a program for temporary storage.

Bug: An error in a computer program or system.

Bulletin board: An electronic communications service where messages can be stored and read by all users.

Bus: A signal pathway that transfers information within a computer.

Byte: A group of eight bits representing one character of data.

Canned software: Packaged software designed for specific applications that is difficult to alter.

Card: A printed circuit board.

Cartridge: A plastic case containing computer software, such as BASIC, in a ROM chip; or a magnetic tape storage device.

Cassette: Standard magnetic tape used to store computer data.

Cathode ray tube (CRT): Picture tube of a television or monitor used to display computer output.

Cell: A memory location containing one unit of data, usually one byte or character. In a spreadsheet, the intersection of a row and column, where a formula, message, or data is stored.

Central processing unit (CPU): The core of a computer system, which interprets and executes instructions.

Character: A single alphanumeric piece of information.

Chip: An integrated circuit etched onto a small piece of silicon.

Circuit: An interconnected assortment of electronic devices used to perform specific functions.

Clock: A timing device which generates regular pulses to synchronize operations within a computer.

Coaxial cable: A form of cable used to connect computers and peripherals for rapid communication.

COBOL: Common Business Oriented Language, a high-level business programming language.

Code: Any system used to represent symbols of data with binary numbers. Alternatively, the series of programming-language statements used to express an algorithm as a runnable program.

Compatible: The ability of computer devices, including software and peripherals, to work with a particular computer system or with each other; a computer is designated "upward compatible" if it can run software designed for the next generation computer and "downward compatible" if it runs software made for the previous model.

Compiler: A program that translates high-level language (source code) into machine language (object code), saving a machine-language program that can later be run directly on a computer. See also interpreter.

Computer: A electronic system consisting of a CPU, memory, I/O devices, and a power supply that stores, retrieves, and processes information.

Computer aided instruction (CAI): Using computers in an educational environment.

Conditional: A transfer of control within a program, dependent upon certain conditions being met.

CP/M: Control Program for Microcomputers. Perhaps the most popular operating system for 8-bit micros, also available for 16-bit computers.

Cps: Characters per second, indicating speed of data transfer.

CPU: Central processing unit.

Crash: The failure (usually fatal) of a program or piece of hardware.

CRT: Cathode ray tube.

Cursor: A special character on the video screen that shows where the next character or symbol entered will appear.

Cursor tracking: Using a stylus and graphics tablet to move a cursor on a video screen.

Daisy wheel: The disk-shaped print element used in letter-quality printers in which a hammer strikes raised characters mounted on projecting spokes, thereby imprinting that character on the page. Also, the kind of printer that uses such an element.

Database: A collection of data files systematically organized for easy access, input, and update of a particular topic.

Data processing: The input, storage, manipulation, and processing of data by a computer.

DBMS: DataBase Management System; application software enabling user to manipulate, store, and retrieve information quickly.

Debugger: Software designed to help users locate programming errors.

Decoder: Software or hardware that translates coded signals; an encoder translates data into code.

Default: A value, state, or option that a computer program or system sets and maintains unless the user specifies otherwise; e.g., the default drive used in a system with two disk drives is automatically the "A" drive.

Degausser: A device used to bulk-erase magnetic tape.

Delimiter: A special character marking the boundaries of a group of related characters in a program; commas, asterisks, slashes, colons, and semicolons are typical delimiters.

Density: Number of bits that can be stored on a magnetic disk or length of tape.

Desktop computer: A computer that fits conveniently on a desktop.

Digital computer: A computer that uses binary numbers to represent data, rather than continuously changing physical variables, such as voltage or electrical current. Most computers are digital computers. Compare with analog computer.

Direct memory access (DMA): A method whereby a peripheral can access a computer's memory without tying up the CPU during input and output operations.

Directory: A list of all files on a disk.

Disassembler: A program that converts machine language into assembly language.

Disk drive: A device that permanently stores data on a magnetic disk and can retrieve it later.

Diskette (floppy disk): Magnetized, flexible plastic disk of (most commonly) 5¼ or 8 inches in diameter used for storage of data.

Disk operating system (DOS): An operating system using disks as secondary storage. Typical functions include formatting disks, allocating space, and saving and retrieving files.

DMA: Direct memory access.

Documentation: The set of written instructions accompanying hardware and software, often including sample work sessions and typical error messages.

Do loop: Programming statement which requires repetition of a program segment until a particular condition is met which halts the loop.

DOS: Disk operating system.

Dot matrix printer: A printer that forms characters of densely packed dots. Cheaper and much faster than a letter-quality printer, but with poorer quality characters.

Double density: A disk capable of storing twice the bits of a normal single-density disk in the same amount of space.

Double-sided disk: A disk capable of storing information on both sides.

Download: To transfer data from one computer to another; usually said of a micro receiving data from a mainframe.

Driver: Program segment that operates a peripheral, such as a printer or modem.

Dumb terminal: A video display terminal not capable of editing or storing data or performing other computer functions on its own.

Dump: To print, display or save the contents from a computer's memory.

Dynamic RAM: A type of memory circuit that is less expensive than static RAM, but that requires continual "refreshing" to hold its data.

Electronic mail: Electronic transmission and reception of data between two computers over normal telephone lines.

Electronic spreadsheet: Program that creates a data grid or worksheet in which data relationships can be analyzed and manipulated; the program will automatically recalculate the entire grid when any data are changed.

Electrostatic printer: A non-impact printer that charges characters onto specially coated paper and then melts dry ink onto the charge, as many photocopiers do.

Embedded command: A special sequence of characters placed within a word-processing text file that is not printed out but commands the program or printer to perform a certain function—halt page numbering, set margin parameters, center a line, or whatever.

Emulate: To imitate the operation of another system, such as a different microprocessor, or communications protocol.

EOF: Acronym for End of File.

Ergonomics: The study of humans using machines.

Fanfold: Continuous-feed paper connected by perforations.

Field: A unit of data within a record.

File: A group of organized data under a common name.

Firmware: Permanent programs stored in ROM.

Floating point representation: A system for processing large numbers quickly in which the decimal is not fixed, but is represented as an exponent.

Floppy disk: Diskette.

Flowchart: A graphic representation of the sequences of a program.

For/next loop: BASIC logic statement that details repetition of a segment a specified number of times.

Formatting: Organizing disk tracks prior to data input, or preparing text for printout.

FORTH: A programming language in which the user's programs, called "words," may be used as new parts of the language. Intended for use in device controllers, it contains a built-in assembly language and is now widely used in business and scientific applications and arcade game programming.

FORTRAN: Acronym for FORMula TRANSfer, a high-level programming language designed primarily for mathematical, engineering, and scientific applications; one of the oldest and most popular languages.

Full-duplex: Means by which two systems communicate simultaneously using different signals. Compare with half-duplex.

Function keys: Command keys that will perform user-defined operations when depressed.

Gateway: A device used to connect two different networks; e.g., domestic and foreign.

Glitch: Any temporary or random hardware malfunction.

Global search: The search for specified data through an entire file, program, or database.

Goto: An unconditional branch statement in high-level programming languages.

Graphics: Symbols, drawings, charts, and graphs formed on a video screen or printer.

Graphics tablet: A device for drawing pictures onto a video screen and into computer memory with a special stylus.

Gulp: Slang for a group of bytes.

Half-duplex: Bi-directional data transmission, but in one direction at a time. Compare with full-duplex.

Hard copy: Computer output of any type on paper.

Hard disk: A mass storage device that uses a rigid magnetic disk to hold megabytes of information.

Hardware: All computer equipment other than programs, including CPU, disk drives, printer, keyboard, video display terminal, etc.

Heuristic: Solving a problem by a mix of rules of thumb and trial-and-error rather than by programming a fixed solution.

Hexadecimal: A concise numbering system based on 16 digits (0-9 and A,B,C,D,E, and F), used by programmers as a shorthand way to represent binary numbers.

High-level language: Programming language that enables user to program with English-like statements and mathematical notations, each of which is a kind of shorthand for many machine-language statements. High-level means closer to humans, low-level closer to machine language.

High resolution (hi res): Indicates image quality on a video screen or printer.

IC: Integrated circuit.

If-then-else: High-level programming language statement that acts on the comparison of data, e.g., If A = B Then C, Else D.

Image processing: Enhancing an image using techniques such as digitizing to analyze subtle relationships between colors, shades, and other elements of a picture.

Impact printer: Printer that forms characters on paper by striking an inked ribbon with a tiny hammer or printhead. Drum, chain, dot matrix, and daisy wheel printers are examples.

Implementation: The installation and testing of computer system hardware and software for specific applications.

Ink-jet printer: Non-impact printer that sprays droplets of ink onto the paper.

Input/output (I/O): Data flow in or out of a CPU.

Instruction set: Built-in procedures which a central processing unit uses to manipulate data; all statements in higher-level languages are made up of many of these instructions.

Integrated circuit (IC): Group of interconnected circuits on a silicon chip.

Interface: The circuitry and software used to connect computers to other computers or peripherals so that data can be transmitted and received; also the act of setting up such a connection.

Interpreter: A program designed to translate high-level language source code into machine-language object code one line at a time during program operation; no machine-language program is saved, so the interpreter must be used each time the high-level program is run. See also compiler.

Interrupt: A brief pause in a program's operation, usually in response to a control signal from a peripheral, so that the CPU can service an input/output device such as a printer or perform some user-specified operation.

I/O: Abbreviation for Input/Output.

Joystick: A manual control lever that directs movement of the cursor around the screen, used principally in computer graphics and games.

Jump: A branch or Goto statement in a program; particularly an assembly-language statement.

Justification: Vertical alignment of the right or left margins of text or graphics.

K: Stands for kilobyte. One kilobyte equals 2^{10} or 1,024 bytes; hence, a 64K RAM board can store 65,536 bytes.

Keyboard: A set of keys like that of a typewriter that allows alphanumeric characters and commands to be entered into a computer.

Keypad: An array of numeric keys either stand-alone or to the right of the QWERTY keyboard used for special purposes.

Keypunch: Keyboard device that records data by punching holes in computer cards.

Kilobyte: 2^{10} or 1,024 bytes. See K.

Language: Software that allows humans to program computers with alphanumeric characters and phrases rather than binary digits.

Laser printer: A non-impact printer that produces dot-matrix characters on a page by electrophotography, much like a photocopy machine.

Letter-quality printer: A daisy wheel, ball, or thimble printer that produces letters of the quality of electric typewriters.

Light pen: A photosensitive pen-like instrument that enables the user to "draw" directly on a video screen.

Line printer: A printer that outputs an entire line of text at one time.

LISP: Acronym for LISt Processing, a high-level programming language used especially in artificial intelligence applications.

Load: To place a program in computer memory.

Log: To "log-on" (or "log-off") means to initiate (or break) communication with a computer.

Logo: A programming language initially designed for children in which versatile "turtle graphics" can be created after minimal coding. Sophisticated data handling functions have made it a good candidate for artificial intelligence studies and other "serious" programming.

Loop: A sequence of instructions in a program that repeat until a certain condition is met.

Low-level language: A programming language that is close to the pure binary language the machine understands, as in machine or assembly language. Faster operation and more compact programs are advantages over high-level language.

Machine language: Lowest-level programming language; a computer can only execute instructions that have been translated (usually by a higher-level language) into its particular machine language.

Magnetic tape: Magnetized recording tape used to store binary computer information.

Mainframe: A large, multi-user computer, primarily used in corporations, universities, and government bureaus.

Main memory: See random access memory.

Mass storage: External, large-capacity storage, such as magnetic disks and tape.

Megabyte: 1,024K bytes, or just over one million bytes.

Membrane keyboard: A flat, pressure-sensitive keyboard.

Memory: The circuitry that stores data in a computer.

Menu: A list of options in a program from which a user can choose various functions; such a program is termed "menu-driven."

Microcomputer: Any relatively small, inexpensive computer that contains a microprocessor using a word length of (most commonly) 8 or 16 bits; used primarily in small businesses and the home. The

distinction between micros and minicomputers is rapidly blurring.

Microfloppy: A diskette with a diameter of 3 to 3½ inches.

Microprocessor: A microcomputer's central processing unit (CPU) occupying a single chip.

Minicomputer: Usually refers to a 32-bit computer with 256K or more of RAM and principally used in small business systems. Compare with microcomputer and mainframe computer.

Mnemonic: An easily remembered word used in place of one harder to remember; assembly-language instructions such as JMP (for "Jump") are mnemonics.

Modem: Acronym for MOdulator/DEModulator, a communications device that translates digital pulses into analog signals (and analog to digital) for rapid transmission of data between computers over telephone lines.

Modular programming: The development of programs by modules, in which logical subsections are written separately by one or many programmers and merged into one, permitting individual modules to be saved for use in other programs.

Monitor: A video display terminal.

Motherboard: The main board in a computer into which printed circuit boards are plugged.

Mouse: A small, hand-held device that, when moved, shifts the cursor around a video screen.

Multiprocessor: A computer with several CPUs handling separate functions for increased efficiency of operation.

Multiprogramming: Technique that allows several unrelated programs to be executed, apparently at the same time, by a single processing unit.

Multitasking: The concurrent execution of two or more related tasks within a single program.

Multi-user: A mainframe system with concurrently usable terminals.

Nesting: Placing instructions as subroutines within other instructions in a program; used most commonly when one For-Next loop contains another or when one subroutine calls another.

Network: The interconnection of computers, terminals, and other I/O devices via cables or telephone lines.

Nibble: One-half byte; four bits.

Non-impact printer: A printer such as a laser or ink-jet printer that does not strike a hammer against a ribbon.

Non-volatile: Memory that retains its contents after power has been turned off.

Number crunching: Large amounts of mathematical computation.

Object code: Machine-language instructions, which are the output of assemblers and compilers.

On-line: Communicating directly with the CPU or a data transmission network.

Operand: Individual data item on which a program operation works. In the statement "If A = 10," A and 10 are operands.

Operating system: Control system that performs such functions as input/output, disk formatting, and file transfer, and resides in main memory while other programs run. Usually includes nonresident utilities supplied with the operating system itself.

Operation code (OP code): An assembly-language instruction.

Optimizer: A program that modifies another program to make it run faster.

OS: Operating system.

Overflow: A condition caused by an arithmetic operation that returns a number too large to be stored in a computer's register. Also used when a program attempts to store too much data in the memory area set aside for it.

Overlay: A technique used when a program is too large for a computer's memory; one part of the program is executed and then removed so other routines can take its place.

Parallel interface: A connection between a computer and peripheral in which all bits are transmitted simultaneously, each over its own wire. Compare with serial interface.

Pascal: High-level programming language often taught to first-time programmers in universities. Named after the 17th-century mathematician Blaise Pascal, it is meant to teach structured programming and is available in both interpreted and compiled versions.

Peripheral: An input/output device under the control of a CPU, including terminals, disk drives, and printers.

Pipelining: A means for increasing computer

speed in which an instruction is fetched from memory before the previous one has been completely executed.

Pixel: Any of the small elements that make up the picture on a video screen; acronym for picture element.

Plotter: A graphics device that draws computer images on paper with a pen.

Port: A male or female input/output connection that links computers and peripherals.

Portable computer: Usually refers to a typewriter-sized general purpose computer that is easily transportable.

Power supply: A device within the computer that converts outlet AC power to the DC power required by the computer.

Printed circuit board: A flat, insulating board containing circuits and electrical components such as transistors, diodes, and switches.

Printer: An output device for producing text and graphics on paper; dot-matrix and letter quality are types of printers.

Printout: Hardcopy (paper) from a printer.

Problem-oriented language: A programming language designed to make it easy to express a particular kind of problem to be solved rather than for efficient translation into machine language. Compare with procedure-oriented language.

Procedure-oriented language: A programming language like COBOL or FORTRAN designed to express the sequence of steps used to solve a problem. (Compare with problem-oriented language.)

Program: Software instructions that tell a computer how to perform specified functions.

Program generator: An application program that generates another program from descriptions of the problem to be solved.

Programmable Read-Only Memory (PROM): A memory chip that can be programmed only once and cannot be altered later except by complete erasure and reprogramming.

Prompt: A message from a program that demands user input for further operation, such as "Quit system (Y/N)?"

Protocol: The set of rules governing the exchange of information between computers in a communications network.

Public-domain software: Software not under copyright and available to everyone.

Pulse: A sudden, but brief surge in voltage or current.

Query language: A high-level programming language that permits access to database files with simple, English-language commands.

QWERTY: The standard typewriter keyboard layout used in most microcomputers.

Random access memory (RAM): Read/write memory directly accessible to the CPU. Programs and data loaded into this storage area can be altered but will not remain in memory after power has been turned off. Compare with read-only memory.

Raster: The pattern of horizontal lines in a video screen scanned by the electron beam of the cathode ray tube to create an image.

Read-only memory (ROM): A memory circuit that holds data permanently and cannot be altered.

Read/write head: A electromagnetic mechanism that reads or records data on a magnetic disk or tape.

Read/write memory: Same as random access memory.

Record: A group of related fields of data treated as a unit, such as the collected information on one person in a mailing list.

Refresh: To regenerate signals continually on a video screen or in dynamic RAM so that the image or information does not fade out.

Registers: Temporary storage locations within a CPU that contain data or instructions to be processed.

Relocatable: Programs or instructions in a program not fixed to any particular address, so that it can reside anywhere in main memory.

RF modulator: Radio Frequency modulator, a device that modifies a computer output signal for display on a television screen.

ROM: Read-only memory.

RPG: Report Program Generator, a high-level programming language specifically designed for business applications.

RS-232: A widely used communications standard for serial interfaces.

Run: To execute a program.

Scrolling: Advancing text vertically or horizontally on a video screen to examine material outside the original viewing area.

Secondary storage: Same as mass storage.

Sector: A pie-shaped section of a magnetic disk used to organize the storage of data. Each block of data on a disk is located by the track (see also) and sector it occupies.

Semiconductor: A material with an electrical conductivity between that of metals and that of insulators; the raw material for transistors and integrated circuits.

Serial interface: A connection between computers and peripherals in which bits are transmitted one at a time. Compare with parallel interface.

Smart terminal: A terminal with a microprocessor that can perform certain functions without assistance from a computer, such as editing, formatting, and simple arithmetic. Compare with dumb terminal.

Software: A set of instructions that tell a computer what to do and how to do it. Compare with hardware.

Solid state: Small, efficient electronic components made of semiconductors.

Source code: A set of instructions written by a programmer that must be translated into machine language by an interpreter or compiler before the computer can execute them.

Speech synthesizer: A computer that simulates the human voice by constructing strings of digitized phonemes, the recognizable sounds that make up a spoken language.

Spreadsheet: See electronic spreadsheet.

Stack: A block of successive memory locations in which data is stored and retrieved on a last-in/first-out basis, like plates on a stack.

Static RAM: RAM that retains its contents as long as power is supplied. Compare with dynamic RAM.

String: Any group of characters treated as a unit; for example, "unit" is a string of four characters.

Structured programming: A group of programming techniques that simplify design, testing, and documentation functions by imposing a structure on all programs.

Subroutine: A group of instructions in a program separate from the main program that perform a dis-

crete function and are often used more than once during a program's execution.

Symbolic language: Any programming language other than machine code.

Synchronous transmission: A mode of transmitting data between computer devices at timed intervals, an expensive, but higher-speed mode of communication than asynchronous transmission.

SYSGEN: SYStem GENerator, a utility that generates an operating system to fit the memory and peripheral parameters of a particular computer. Part of CP/M.

Telecommunications: The long-distance transmission of data by telephone, TV, or radio waves.

Teleprinter: A terminal with a built-in printer used in telecommunications.

Terminal: An input/output device consisting of a keyboard attached to a video display and/or printer.

Thermal printer: A non-impact printer that uses a heated element to form dot-matrix characters on specially coated, heat-sensitive paper. Some new models use the element to melt ink from a transfer material onto the paper.

Thimble printer: An impact printer that uses a thimble-shaped print element with raised characters to print letter-quality characters on paper.

Timesharing: The use of one central processing unit (usually a mainframe computer) by more than one user at a time.

Toggle: Any command that, given repeatedly, alternately turns a function on and off.

Top-down programming: Development of a program by breaking the task to be accomplished into smaller and smaller subproblems until they can be translated directly into programming-language statements. One of the techniques of structured programming.

Track: One of the concentric rings on a disk (or parallel channels on a tape) used to organize the storage of data.

Tractor feed: A printer mechanism that guides fan-fold paper by means of sprockets that fit into pre-cut holes in the paper.

User friendly: Easy to understand and operate.

User group: A group of people who share information for a specific computer system or program through vendors, publications, or meetings.

Utility: A program that performs special tasks such as copying programs and initializing data disks to other computer formats.

Variable: Memory location used by a program for temporary storage of data that may change as the program is run; referred to in the program by a variable name. In the statement "A=2," "A" is a variable with the value 2.

VDT: Video Display Terminal.

Very large scale integration (VLSI): Etching of a large number of integrated circuit components onto a silicon chip; usually between several hundred thousand and 1,000,000.

Video display terminal (VDT): A screen such as that of a television set on which data and graphics are displayed.

Virtual memory: A system that simulates greater storage space than actually exists in main memory

by loading parts of a program or data into memory and replacing them as necessary.

Voice recognition: The ability of a computer to recognize spoken words and phrases.

Volatile memory: Memory that does not retain data once the power has been turned off.

Winchester disk: A hard disk.

Word processing: The creation, manipulation, storage, and printing of text documents such as letters and manuscripts.

Word wrap: A function in word processing in which a word too long to fit within a margin is automatically placed on the next line.

Write-protection: The ability to designate a magnetic storage medium such as a disk or tape "read-only" to avoid inadvertent writing over (erasing) of data.

HARDWARE DIRECTORY

Acorn Computers Corp.

400 Unicorn Park Drive
Woburn, MA 01801
(800) 225-8001

ACT (North America), Inc.

3375 Scott Boulevard
Suite 336, Santa Clara, CA 95051
(408) 727-8639

Actrix Computer

1259 Bering Drive
San Jose, CA 95131
(408) 263-3660

Advanced Logic Systems

1195 East Arques Avenue
Sunnyvale, CA 94086
(800) 538-8177

Advanced Systems Concepts, Inc.

435 North Lake Avenue
Pasadena, CA
(818) 793-8971

Alien Group

27 West 23rd Street
New York, NY 10011
(212) 741-1770

Alphacom, Inc.

3031 Tisch Way
San Jose, CA 95128
(408) 559-8000

Amdek

2201 Lively Boulevard
Elk Grove Village, IL 60007
(312) 364-1180

Amlyn Corporation

2450 Autumnvale Drive
San Jose, CA 95131
(408) 946-8616

Ampex Corp.

200 North Nash Street
El Segundo, CA 90245
(213) 640-0150

Anacom General Corp.

Computer Products Division
1116 Valencia Drive
Fullerton, CA 92631
(714) 992-0223

Anadex, Inc.

1001 Flynn Road
Camarillo, CA 93010
(805) 987-9660

**Applied Digital Data Systems
(ADDS)**

100 Marcus Boulevard
Hauppauge, NY 11788
(516) 231-5400

Apple Computer, Inc.

20525 Mariani Avenue
Cupertino, CA 95014
(408) 996-1010

Atari, Inc.

1265 Borregas Avenue
Sunnyvale, CA 94086
(408) 745-2000

Axiom Corp.

1014 Griswold Avenue
San Fernando, CA 91340
(213) 365-9521

Axlon, Inc.

1287 Lawrence Station Road
Sunnyvale, CA 94089
(408) 747-1900

Aydin Controls

414 Commerce Drive
Fort Washington, PA 19034
(215) 542-7800

Beehive International

4910 Amelia Earhart Drive
Salt Lake City, UT 84125
(801) 355-6000

Bizcomp Corporation

532 Weddell Drive
Sunnyvale, CA 94086
(408) 745-1616

Bluestem Productions

2327 Lafayette Road
Wayzata, MN 55391
(612) 757-5470

BMC

16830 South Avalon Boulevard
Carson, CA 90746
(213) 515-6005

Bytec Comterm, Inc.

8 Colonnade Road
Ottawa, Canada K2E 7M6
(613) 727-1900

Bytewriter

125 Northview Road
Ithaca, NY 14850
(607) 272-1132

Centronics Data

1 Wall Street
Hudson, NH 03051
(603) 883-0111

Cermetek Microelectronics, Inc.

1308 Borregas Avenue
Sunnyvale, CA 94089
(408) 752-5000

Chalk Board, Inc.

3772 Pheasantdale Road
Suite 140
Atlanta, GA 30340
(404) 447-6711

Championship Electronics

711 Grandview Drive South
San Francisco, CA 94030

Chessell-Robocom Corp.

125 Pheasant Row
Suite 2B
Newtown, PA 18940
(215) 968-4422

Colby Computer

849 Independence Avenue
Mountain View, CA 94043
(415) 968-1410

Coleco Industries, Inc.

999 Quaker Lane South
West Hartford, CT 06110
(203) 725-6000

**Communications Research
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Bellevue, WA 98005
(800) 426-8075
(206) 881-9550

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20333 FM149
Houston, TX 77070
(713) 370-7040

Compupro

3506 Breakwater Court
Hayward, CA 94545
(415) 786-0909

Compuscope

6400 Signal Street
Tillamook, OR 97141

Computer Distribution Associates

53 South Third Street
Oxford, PA 19363
(215) 932-4807

Comrex International, Inc.

3701 Skypark Drive #120
Torrance, CA 90505
(213) 373-0280

Connecticut MicroComputer, Inc.

36 Del Mar Drive
Brookfield, CT 06804
(203) 354-9395

Control Data Corp.

Peripheral Products Division
8100 34th Avenue, South
Minneapolis, MN 55420
(612) 853-8100

Corona Data Systems

31324 Via Colinas
Section 110
Westlake Village, CA 91361
(213) 706-1505

Corvus Systems

2029 O'Toole Avenue
San Jose, CA 95131
(408) 559-7000

Cromemco, Inc.

280 Bernardo Avenue
Mountain View, CA 94039
(415) 964-7400

CTI Data Corp.

5275 North Boulevard
Raleigh, NC 27604
(919) 876-8731

CXI

10011 North Foothill Boulevard
Cupertino, CA 95014
(408) 725-1881

Data General Corp.

Route 9
15 Turnpike Road
Westborough, MA 01801
(617) 485-9100

Data Impact Products

745 Atlantic Avenue
Boston, MA 02110
(617) 482-4214

Datapoint Corp.

9725 Datapoint Drive
San Antonio, TX 78284
(512) 699-7000

Datasouth Computer Corp.

474 Dwight Evans Road
Charlotte, NC 28201
(704) 523-8500

Davong Systems, Inc.

217 Humboldt Court
Sunnyvale, CA 94086
(408) 734-4900

Diablo Systems, Inc.

901 Page Avenue
Fremont, CA 94537
(415) 498-7000

Digital Equipment Corp.

2 Mount Royal Avenue
Maynard, MA 01755
(800) 344-4825

Dynax, Inc.

Division of Kanetmatsu-Gosho
5698 Bandini Boulevard
Bell, CA 90201
(213) 727-1227

Eagle Computer, Inc.

983 University Avenue
Los Gatos, CA 95030
(408) 395-5005

Eastman Kodak Co.

343 State Street
Rochester, NY 14651
(716) 724-4000

Electrohome (USA), Ltd.

250 Wales Avenue
Tonawanda, NY 14150
(716) 694-3332

Electronic Control Systems

22000 Romar Street
Chatsworth, CA 91311

Emri Computer

P.O. Box 4878
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Ottawa, Ontario
Canada K1S 5D1

Enhancement Technology Corporation

P.O. Box 1267
Pittsfield, MA 01202
(413) 445-4263

Epson America, Inc.

3415 Kashiwa Street
Torrance, CA 90505
(213) 373-9511

Floppy Disk Services, Inc.

741 Alexander Road
Princeton, NJ 08540
(800) 223-0306
(609) 799-4440

Franklin Computer Corp.

7030 Colonial Way
Pennsauken, NJ 08109
(609) 488-0600

Fujitsu Microelectronics

3320 Scott Boulevard
Santa Clara, CA 95051
(408) 727-1700

Futurehouse

P.O. Box 3470
Chapel Hill, NC
(919) 967-0861

Genie Computer Corporation

31131 Via Colinas #607
Westlake Village, CA 91362
(213) 991-6210

GRiD Systems Corp.

2535 Garcia Avenue
Mountain View, CA 94034
(415) 961-4800

GSR Computers

60-10 69th Street
Maspeth, NY 11378
(212) 476-2091

Hardsell

P.O. Box 565
Metuchen, NJ 08840

Hayes Microcomputer Products, Inc.

5923 Peachtree Industrial Boulevard
Norcross, GA 30092
(404) 449-8791

Heath Company

Benton Harbor, MI 49022
(616) 982-3200

Hewlett Packard

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1000 North East Circle Boulevard
Corvallis, OR 97330
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Hitachi America

401 West Artesia Boulevard
Compton, CA 90220
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Infoscribe, Inc.

2720 South Croddy Way
Santa Ana, CA 92704
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Interactive Structures

146 Montgomery Avenue
P.O. Box 404
Bala Cynwyd, PA 19004

International Business Machines Corp.

Information Systems
Boca Raton, FL 33432
(395) 998-2000

C. Itoh Electronics, Inc.

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Los Angeles, CA 90066
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Juki Industries of America, Inc.

20437 South Western Avenue
Torrance, CA 90501
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JVB Electronics

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Kaypro Corp.

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Keytronic Corp.

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Kimtron Corp.

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Santa Clara, CA 95050
(408) 727-1510

Koala Technologies Corp.

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Suite 125
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Leading Edge Products, Inc.

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(617) 828-8150 (in Massachusetts)

Lear Siegler, Inc.

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Anaheim, CA 92803
(714) 778-3500

Legend Industries, Ltd.

2220 Scott Lake Road
Pontiac, MI 48054
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Lexicon Corporation of Miami

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Fort Lauderdale, FL 33313
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Liberty Electronics USA

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Link Systems

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Santa Monica, CA 90404
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LNW Computer Corp.

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Lobo Systems

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Magellan Computer

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Mark Data Products

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MFJ Enterprises, Inc.

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Micro Display Systems, Inc.

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Micro General Corporation

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Microlog Corp.

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Micro Logic Corp.

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Hackensack, NJ 07602
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Micro Peripherals, Inc. (MPI)

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Chatsworth, CA 91311
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Micro-Sci Corporation

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(714) 241-5600

Microsoft Corporation

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Bellevue, WA 98004
(206) 828-8080

Micro-Term, Inc.

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Morrow Designs

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Mountain Computer, Inc.

300 El Pueblo Road
Scotts Valley, CA 95066
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NEC Electronics

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Elk Grove, IL 60007
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NEC Information Systems, Inc.

5 Militia Drive
Lexington, MA 02173
(617) 862-3120

Newport Controls

Bishop, CA 93514
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North Star Computers, Inc.

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San Leandro, CA 94577
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Novation, Inc.

20409 Prairie Street
Chatsworth, CA 91311
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(213) 996-5060 (in California)

Okidata Corp.

111 Gaither Drive
Mount Laurel, NJ 08054
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Omnitronix

P.O. Box 12309
Seattle, WA 98111

Orchard Technology

47790 Westinghouse Drive
Fremont, CA 94539
(415) 490-8586

Otrona Advanced Systems Corp.

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Owen Davies, a founding editor and currently a contributing editor of *Omni*, is co-author of the *Omni Online Database Directory* and editor of the *Omni Complete Catalog of Computer Software*. The fact that he owns only six computer systems can be attributed to the small size of New York City apartments.



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